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Electronics in the Post-war World

For too many years now has the importance of electronics been overshadowed in the public mind by the entertainment value of one of its greatest manifestations —radio broadcasting. It is only natural that this, one of the marvels of the century, should capture the public imagination to the extent that it has done, but at the same time there is no reason why kindred, and even more important branches of electronics, should be relatively so little known. The vast part played in the world's economy by radio communication (as distinct from broadcasting) is hardly even guessed at by the layman.

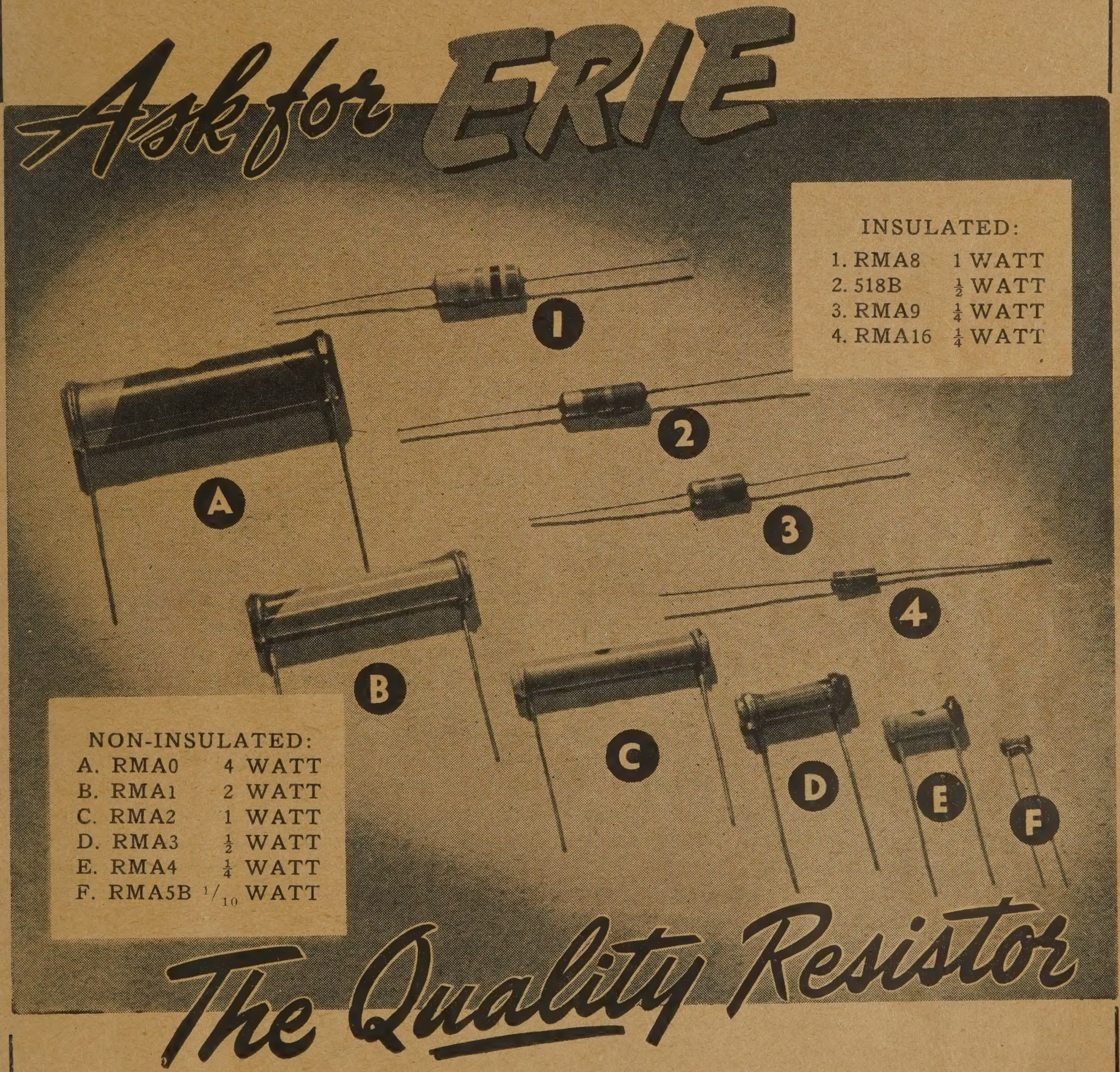
Radio communication itself is now only one item in an ever-growing list of electronic applications, the importance of which is daily increasing. In the last decade, uses have been developed for electronic techniques which were previously undreamed of. Industrial men, doctors, engineers and workers in all branches of pure and applied science, have been provided with powerful new tools for investigating and solving their problems—problems which, in many cases, have defied solution till electronics supplied the key to them.

To some, this may seem a sweeping statement, and so it is, but it is none the less true, and in direct proportion to its truth is the importance of electronics to the world at large and to this country in particular. This being the case, the importance of having a sufficiently large body of men trained in electronic engineering can hardly be overestimated. At present a vicious circle exists, whereby the full exploitation of electronic techniques is hindered by the lack of men with good enough qualifications and sufficiently advanced training. The incentive to suitable young men to study advanced electronics is likewise hindered by the lack of positions for them once they are fully trained.

There are signs, however, that a break is occurring in this vicious circle—a break due solely to the growing realisation among industrialists and others that electronic methods can be of great assistance to them. One very tangible sign is the provision at Canterbury University College of a post-graduate course in electronics, and the probable future creation of a chair of electronics in the Engineering School at the same College. Another is the retention by the Department of Scientific and Industrial Research of a nucleus of the war-time Radio Development Laboratory as an electronics division of the Dominion Physical Laboratory. These things are encouraging, and are possibly all that can be expected at present.

However, there is certainly no lack of appreciation in Great Britain or America, either of scientific development generally, or of electronics in particular. It is recognised that in defence alone electronics will, in the future, play a part bigger by far than was its share in the last war.

For this reason alone, quite apart from any other, New Zealand should take care to keep in the forefront of peace-time electronics, just as she did during the war. For, whether peace or war is to be our future lot, we now live in an electronic age, when none can say that this branch of applied science will not ultimately exceed all others in its effects upon mankind.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RADAR—Height Finding by Radar

The first use to which radar was put was that of giving long-range warning of the approach of enemy aircraft. We have shown in earlier articles in this series how the range and bearing of an aircraft from the radar station may be measured with considerable accuracy. However, if the position of an attacking aircraft is to be specified exactly, its height must be known as well as its range and bearing. This may at first sight appear to be rather an academic requirement, since the "hostile" can be tracked perfectly well without its height being known. However, when the matter is considered from the point of view of a fighter force despatched to intercept the enemy before he can reach his objective, it can be seen that information on the enemy's height is really essential if easy interception is to be realised, and in some cases if it is to be successful at all.

This fact was early realised by those responsible for designing Britain's air warning system, with the result that much effort was expended in developing a successful radar height-finding device.

Fig. 1 gives a pictorial statement of the problem of finding an aircraft's height from a radar station at A. By the usual method, the range R. of the target is known, so that, if some means can be found of estimating the angle of elevation of the target, its height may be calculated from the simple trigonometrical relationship $h = R \sin \phi$ where is the angle of elevation.

In order to find , the well-known vertical directional pattern of an aerial is used. Suppose we have an aerial at a certain height on a mast. It will produce a vertical radiation pattern consisting of a number of lobes, such as the ones drawn on Fig. 1. The angle of elevation of the tip of the lowest lobe depends upon the height of the aerial, and is lower the higher the aerial. Thus, referring again to Fig. 1, the solid lobe would be produced by an aerial much higher than another which would give the dotted lobe.

Now, considering the radiation pattern of the higher aerial, i.e., the solid lobe in Fig. 1, this shows that, if an aircraft is on the ground, there will be no signal received by the receiving aerial. However, as the aircraft becomes higher, a signal will appear, and will become progressively greater until the angle of elevation of the aircraft is 5 degrees, corresponding with the maximum of the aerial's pattern. Then, as the aircraft flies higher still, the signal will become smaller, until at some still greater angle of elevation it will disappear altogether.

Now, let us consider the lobe (shown dotted) belonging to the lower aerial. In this case, also, the signal will be zero when the target is at ground level, and will increase as its height increases. This time, however, the strongest signal

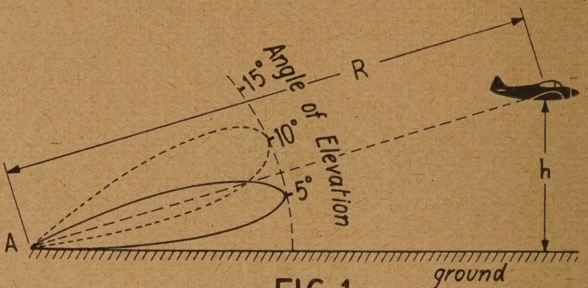


FIG.1

is not received until the target is at an angle of elevation of 10 degrees. Now, suppose we are able to observe simultaneously and separately echoes received on both the high and low aerials. If this is done, as the aircraft increases its height from zero feet up, we should notice that the relative strengths of the echoes received on the two aerials will be constantly changing. For instance, when the angle of elevation of the target is lower than about 7 degrees, the signal from the high aerial will be stronger than that from the low aerial, but as the aircraft approaches 7 degrees, the ratio between the signals from the high and low aerials will become smaller. When the aircraft reaches this angle of elevation (which is its position drawn in Fig. 1), the signals from the two aerials will be equal. As the aircraft goes higher still, the signal from the low aerial becomes stronger than that from the high one, and so on.

From this it can be seen that, if we know the exact patterns of the high and low aerials, we can work out what the ratio of the signals should be for any angle of elevation of the target. When this has been done, and we then observe, say, that the signals are equal, we know in the example used that the target must be at an angle of elevation of 7 degrees. This principle is the basis of the height-finding systems used on all but microwave radar sets.

In one of the G.C.I. or Ground Controlled Interception types of radar set, two receiving

aerial systems are used, one $7\frac{1}{2}$ft. high and one at $12\frac{1}{2}$ft. By means of electronic switching, these aerials are used alternately at a rate of many times a second, and the echoes from each are displayed side by side on the time-base of the A-scope display tube in the set. Thus, each aircraft is shown as two side-by-side echoes whose height, and therefore relative signal strength, can be found directly by simple measurement. From the A-scope, the range also is measured, and the two quantities, range and ratio of signals from the two height aerials are applied to a special chart from which the aircraft's height can now be read.

AMBIGUITIES

The system outlined works very well indeed under favourable conditions, but in practice there are a number of difficulties which occur. Chief among these is the question of ambiguity, which can be seen from Fig. 2. Although our discussion has been confined solely to the lowest lobes in the patterns of each aerial, it must be remembered that there will be one lobe for every half-wave-length that the aerial is elevated above the ground. In Fig. 2, the lobes have been drawn differently, showing the two lowest lobes of the high aerial and the lowest lobe of the low aerial. In Fig. 1 the second lobe of the high aerial was omitted in the interests of clarity. Here again, the bottom lobe of the high aerial has its maximum response at 5 degrees elevation, and that of the low aerial comes at 10 degrees. In addition, however, the second lobe of the high aerial has its maximum at 15 degrees. Now, taking the simplest case where the responses from the two aerials are equal, we find that the angle of elevation of the aircraft could be either 7 or 13 degrees, or if the second lobe of the low aerial is taken into account, even 19.8 degrees. The question now arises as to which of these answers is the correct one!

It will be remembered that some way back we assumed that we could tell which of the echoes belonged to each aerial, and in the practical equipment this is a fact, so that a good many cases of ambiguity are ruled out for a start. However, in the case we are now considering, this knowledge does not help. Instead, use is made of the fact that the signal produced by the bottom lobes of the two aerials are in phase, while that from the second lobe of the high aerial is out of phase with that of the two bottom lobes. Thus, if a switching arrangement enables us to combine the responses from the two aerials before they feed into the receiver, and to compare this combined signal with the one from the high aerial alone, the ambiguity will be resolved. The reason for this is that if the aircraft is in the bottom lobe of both aerials, the combined signal will be greater than that from the high aerial, but if the aircraft is in the second lobe of the high aerial, combining the signals will give a smaller resultant signal,

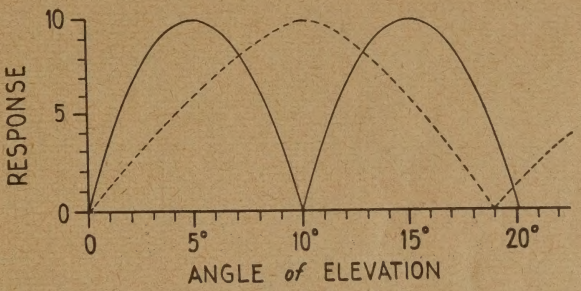


FIG. 2

since the individual ones are out of phase and tend to cancel each other. In this way, if we throw our aerial switch to this new position and find that we have an increased signal, then the correct angle of elevation is 7 degrees and not 13 degrees.

In practice, the heights of the aerials, and therefore the manner in which the patterns overlap, are adjusted so that a minimum number of ambiguities will occur. Thereafter, the remaining ones can be resolved (a) by knowing which echo belongs to which aerial, and (b) by comparing the combined response from the two aerials with that from the high one.

OTHER DIFFICULTIES

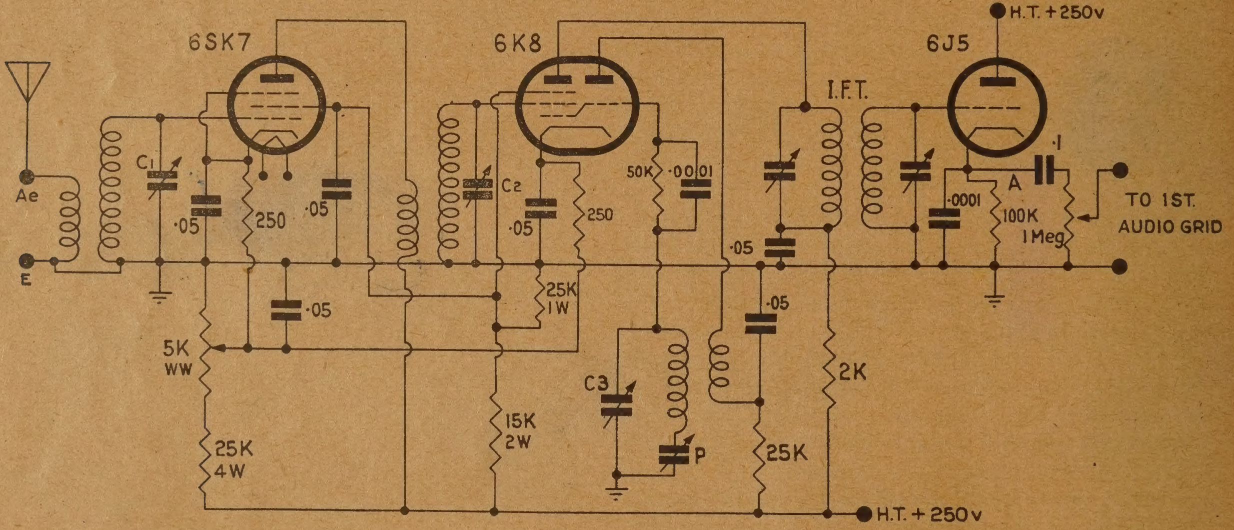
Enough has now been said of this one method of height-finding to indicate that it is the most difficult radar measurement to make accurately, and is also less precise than the measurement of range and bearing. The main reason for the comparative inaccuracy of the method is that it depends for its success on the knowing as exactly as possible the exact shape of the radar's radiation pattern in vertical plane. This, in turn, depends upon the site of the radar, and on a poor site will be different for different bearings. For instance, for successful height-finding, the site must be perfectly level for some distance round the radar set, and there must be no obstructions in the way of buildings, hills, or overhead wires within certain well-specified distances. Again, although the earth may be quite level, its reflection properties may change at different bearings,

(*Continued on page 48.*)

A HIGH QUALITY BROADCAST TUNER

Many people who have built good quality audio amplifiers for gramophone or other use wish to take advantage of the quality of the amplifier in order to obtain higher fidelity from local broadcast stations. A time-honoured method of doing this is to construct a tuner consisting only of a stage of R.F. amplification, followed by a diode or infinite impedance detector. However, this scheme has several disadvantages. Although such a tuner is able to give good quality from the stronger local stations, it sometimes shows up very badly in receiving the weaker locals, such as the auxiliaries 2YC, 3YL, etc. One reason for this is that both the diode and infinite impedance detectors require a rather large signal if their distortion is to be kept very low. The single detector is a 6J5 used as an infinite impedance detector. The output of the latter is taken to the input of the audio amplifier.

The circuit is quite conventional, except that it uses a manual gain control instead of A.V.C. It would have been possible to use a separate diode for the latter and to omit the manual gain control, but this was considered inadvisable, as it would not be particularly effective, and would probably allow overloading to occur in the mixer stage on very strong local signals, with consequent heavy distortion. Therefore, it was omitted and recourse was had to the manual control. This is rendered more effective by taking the common cathode lead of the 6K7 and 6K8 to a source of positive voltage (a voltage



R.F. stage arrangement certainly has plenty of bandwidth, and sometimes even too much, as evinced by poor selectivity. It is because of this very bandwidth that distortion in both tuner and amplifier must be kept to a minimum, for if a receiver is capable of reproducing the higher audio frequencies, any distortion present shows up in a way that never occurs when the high frequency response is restricted.

The writer has had the present tuner in operation for quite some time, and has found it very satisfactory indeed. It has much more gain than the usual simple T.R.F. affair, so that a good strong signal is delivered to the diode from all the local stations, and at night from the other main stations as well. For this reason, distortion is very low. The bandwidth is quite great enough to allow a high frequency response not achieved in ordinary sets, so that a real advantage occurs in using the tuner to feed a good quality amplifier and loud-speaker.

THE CIRCUIT

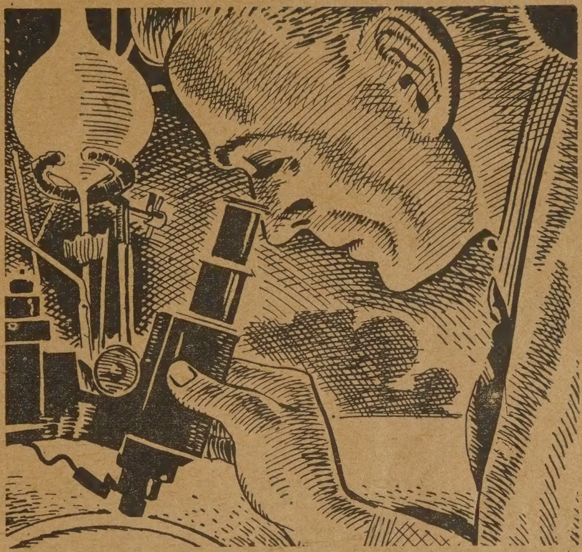
The tuner is a superheterodyne in which the I.F. stage has been omitted. The mixer section of the 6K8 feeds straight to the second detector through a single 465 kc/sec. I.F. transformer. The second divider fed from the H.T. line) rather than by simply including a variable resistor between cathodes and earth.

DECOUPLING

It will be noted that rather comprehensive decoupling has been used in the R.F. and mixer stages. This is not so much to prevent oscillation, for such a circuit is hardly likely to be so afflicted unless very poorly laid out and wired up, but is included so as to prevent all traces of regeneration. If regeneration is present, even though it may not be sufficient to cause oscillation, it can seriously affect the performance of the tuner by causing the selectivity curve to be lop-sided, so that only one side-band can be tuned in properly, the other being partially lost. In this connection, it is important that bypass condensers be connected as shown in the cathode circuit. The cathodes of the 6SK7 and 6K8 are both bypassed at the pins themselves, and a third 0.05μf. condenser is used right at the moving arm of the 5k. gain control potentiometer. Similarly, the 2k. and .05μf. decoupling circuit in the 6K8 plate lead should on no account be omitted.

OUTPUT ARRANGEMENTS

A big advantage of the infinite impedance detector is that, like the cathode follower, it has a low output impedance. In the circuit a 0.1μf. blocking condenser and 1 meg. volume control pot. are shown at the output of the 6J5. However, these are necessary only if the amplifier with which the tuner is to be used has no volume control at the input. They have been included in the circuit only for the sake of completeness, **and should not be mounted on the tuner unless the output lead is very short.** The point A is the place where the output lead from the tuner should be taken off if there is more than a few inches between the tuner and the amplifier. In the writer's case, the tuner successfully feeds two amplifiers, one in the same room and the other in a different room about a hundred feet away. A pair of twisted wires is used to feed the remote amplifier from the points A and earth, and even though this wire is unshielded, there is no noticeable loss of high frequency response, and so little hum as to be negligible. This is a direct consequence of the low output impedance of the detector circuit. Any other detector would need either a transformer or a cathode follower to enable a long open line to be connected to it without introducing excessive hum, or causing high frequency loss.



AN INTRODUCTION TO WIDE-BAND AMPLIFIERS

PART II

Part I of this article outlined the main causes of the dropping-off of the response in resistance-coupled amplifiers, and proceeded to discuss how the high-frequency response could be extended beyond the audio range. At the close of Part I were given the reasons why triodes are generally unsuitable for use in very wide-band amplifiers, and why pentodes are commonly used in these circuits.

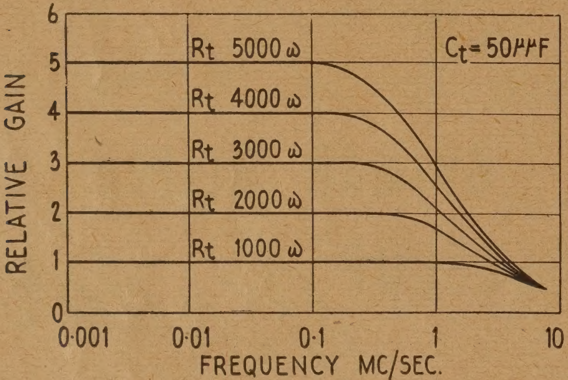


FIG. 4

Fig. 5 reproduced here shows the generalised medium and high-frequency response curve of any resistance-coupled amplifier stage, giving a "plot" of the relative gain in terms of the quantity f/fo, where f is the actual frequency, and fo is the frequency at which the reactance of the total shunt capacity Ct equals the value in ohms of the total shunt resistance Rt. The latter is the resultant of the load resistance Rl, the following grid resistance Rg, and the plate resistance rp, all in parallel.

Fig. 4, also reproduced here, gives the frequency response in five actual cases where Ct has a value of $50\mu\mu f$, and Rt has values of 1000 to 5000 ohms. It can be seen from Fig. 4 that reducing the value of Rt (which in practice is done by reducing Rl) proportionately decreases the mid-frequency gain, and at the same time raises the frequency at which the response drops by 3 db. from the mid-frequency response. Thus, it can be said that the price paid for increased high-frequency response is a reduction of overall stage gain. To take a numerical example: If the tube used in the stage referred to in Fig. 4 is a 6AC7/1852, which has a mutual conductance of 9 ma./v., the gain at medium frequencies when Rt = $5000\,\omega$, is equal to:

$$gm \times Rt = \frac{9}{1000} \times \frac{5000}{1} = 45 \text{ times}$$

If, however, Rt is reduced to 1000 ohms, the gain is now only nine times, but as a result, the response is now "flat" up to 1 mc/sec., and is within 3 db. of the mid-band response as high as 3.18 mc/sec.

A LIMIT SET TO REDUCING Rt

If we attempt to obtain still wider response by the simple expedient of reducing the value of Rl (and therefore of Rt), a point is ultimately reached where the stage gain is unity—and no amplification exists. This is carrying a workable scheme to ridiculous lengths, but serves to show that, even before this point is reached, the stage gain will be so low that, if a high-gain amplifier is to be constructed, an uneconomically large number of stages would need to be employed.

It also shows, however, the necessity for very high mutual-conductance tubes if wide-band amplifiers are to be constructed at all, and explains why valves such as the American 6AC7/1852, the Dutch EF50, and the English SP41 were designed. Without these tubes and others like them, wide-band amplifiers, and therefore electronic television, radar, and other modern devices, would be virtually impossible.

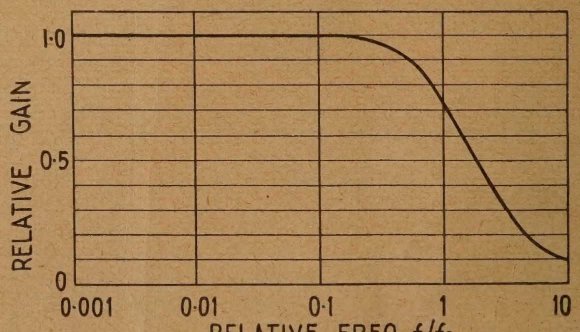


FIG. 5

HIGH FREQUENCY COMPENSATION

It is in order to offset to some extent the loss of gain with increasing band-width, that

special high-frequency compensation circuits have been developed.

So far we have considered only resistances and capacities as coupling elements between valves, but at this point the use of inductances comes into the picture. The simplest type of inductive high-frequency compensation is shown in Fig. 7. In this circuit only one change has

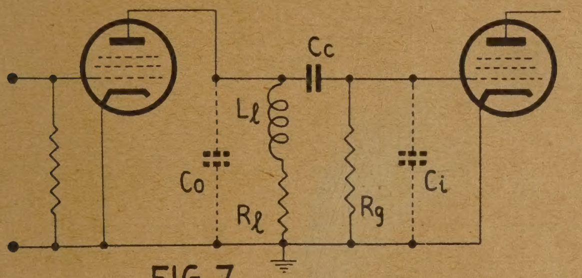


FIG. 7

been made from the uncompensated stage shown previously in Fig. 2, namely, the addition in series with the load resistance Rl of a load inductance Ll. If Ll was short-circuited, Fig. 7 would be exactly the same as Fig. 2. How, then, can the addition of Ll assist in raising the high-frequency response, and how can its value be calculated in order to give a specified response curve? In order to answer these questions, it is necessary once more to have recourse to the simplified or equivalent circuit. This is shown in Figs. 8 (a) and (b). Fig. 8 (a) is the equivalent circuit representing exactly the behaviour of Fig. 7 at medium and high frequencies, while Fig. 8 (b) shows the equivalent low-frequency

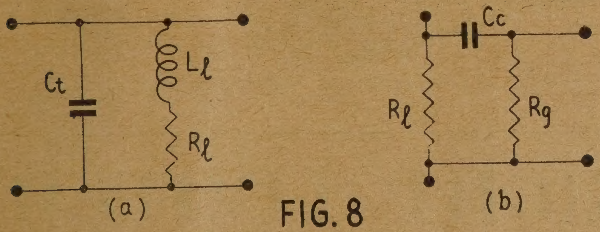


FIG. 8

circuit. Disposing first of all of Fig. 8 (b), this points out that the inductance Ll has no effect whatever on the low-frequency operation of the stage. This is because Ll has a value of only a few millihenries at most, so that, for low frequencies, it can be regarded as a short circuit. Fig. 8 (b) is therefore exactly the same as the equivalent low-frequency circuit for Fig. 2, which was given in Part I as Fig. 3 (b).

In similar fashion, Fig. 8 (a) is analagous to Fig. 3 (a), but is not identical with it, for at high frequencies Ll has appreciable reactance and will therefore come into play in determining the high-frequency response.

A glance at Fig. 8 (a) is sufficient to show that whatever the value of Ll, we now have a tuned circuit in the plate lead of the amplifier, and that the resonant frequency of this tuned circuit is determined by the values of Ct and Ll. In addition, we have in Rl a resistance in series with the capacity and inductance of this circuit, so that it will be highly damped. In other words, the tuned circuit formed by the addition of Ll has a low Q.

As in any other amplifier which has a tuned circuit in its plate lead, the circuit of Fig. 7 can therefore have a peak in its response, at the

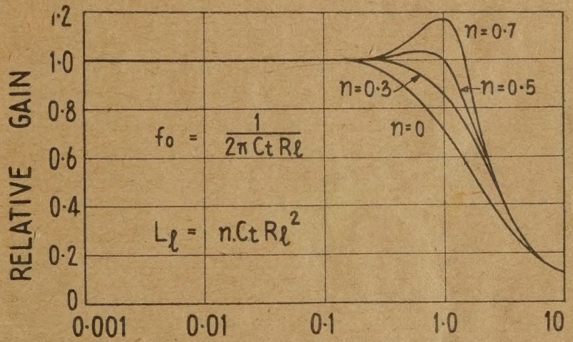


FIG. 9 f/fo RELATIVE FREQUENCY

resonant frequency of the tuned circuit. Thus, without going any further into the matter, it can be seen that, if the Q is high enough, and the resonant frequency is suitably chosen, the amplifier can now be made to have a rising response at high frequencies if desired. This fact is illustrated in Fig. 9, where four response curves are given for an amplifier stage as in Fig. 7, the only variable being the value of Ll. It can be seen that, for a value of $n = 0$ (which means that $L = 0$, and the stage is uncompensated), the response curve is exactly that of Fig. 5, and serves as a basis of comparison. Thus, when Ll has higher values than zero, it can be seen that the extreme high frequency response is lifted, and that when n has a value greater than 0.5, a peak does appear as suggested above. The exact significance of the value of the number n will be treated a little later.

EXPLANATION OF FIG. 9

It will be noted first of all that Fig. 9 is drawn on the same basis as Fig. 5, that is, the gain is given relative to a value of 1 in the mid-frequency range, and frequency is depicted as

the ratio f/fo, of actual frequency to fo, where the reactance of Ct equals the value of Rt in ohms. This fact is expressed mathematically in the top equation in Fig. 9. The lower equation gives the value of Ll in terms of Rl and Ct, and a number n. *This number specifies the resonant frequency of the tuned circuit Ll, Ct in terms of the reference frequency fo.*

Thus, all that is required in order to design a stage using shunt compensation (as the circuit is called) are the two formulae given on Fig. 9.

If f_1 is the resonant frequency of the tuned circuit Ll.Ct, the following relation holds:—

$$f_1 = fo/\sqrt{n}.$$

This means that the smaller the value of n, the higher the value of f_1. On Fig. 9 the highest value of n shown is 0.7, which gives f_1 as approximately equal to 1.2 fo. It can be seen, therefore, that, when the tuned circuit resonates at approximately 1.2 times the frequency fo, a pronounced rise in the high-frequency response takes place, and we have what is known as *overcompensation.* In this particular case, it can be seen that the peak occurs almost exactly at fo. The value of $n = 0.5$ (which puts f_1 at about 1.43 times fo) gives a curve that is slightly overcompensated, but which causes the amplification at fo to equal the mid-band gain. Thus, if it is desired to keep the gain constant up to fo, a value of $n = 0.5$ or slightly smaller, is the best to use if overcompensation is to be avoided.

DESIGN PROCEDURE

Most readers of this article will be interested in the practical problem of designing a wide-band amplifier stage, so that at this point it is perhaps advisable to outline the necessary steps in the procedure.

(1) Decide on the frequency to which "flat" response is to be obtained, and call this frequency fo.

(2) From the tube manuals, find out the output capacity Co of the tube to be used, and the input capacity Ci of the following valve. Then $Ct = Co + Ci +$ say 10 to 15$\mu\mu f$. for socket and wiring capacities.

(3) Find Rl from the relation

$$Rl = \frac{1}{2\pi.fo.Ct}$$

(4) Choose a value for n (say 0.5).

(5) Find the value of Ll from

$$Ll = n.Ct.Rl^2$$

(6) Find from one of the available winding charts the number of turns, size of wire and former to give an inductance equal to Ll.

As an example of this procedure, the following is presented:—

It is desired to design a stage using a 6AC7/1852, followed by a second tube of the same type, which is to be "flat" to 2 mc./sec.

(i) fo = 2 mc./sec.

(ii) From the tube manuals Co = 5$\mu\mu f$., and Ci = 11$\mu\mu f$. Allowing 12$\mu\mu f$. for socket and stray capacities,

$$Ct = 5 + 11 + 12 = 28\mu\mu f.$$

(iii) Rl from the formula is 2838 ohms.

(iv) n is chosen as 0.5.

(v) From the formula, Ll = 112.8μH.

(vi) The required inductance may be wound with 84 turns of 30-gauge enamelled wire on a 1 in. diameter former.

The gain of the stage will be gm. Rl, which gives

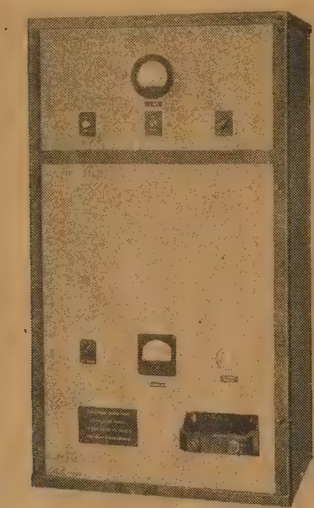
$$\frac{9 \times 2838}{1000} = 25.6 \text{ approx.}$$

(Continued on page 47.)

AN ELECTRONIC MAGNETISER

By N. V. Ryder and F. F. Evison, Dominion Physical Laboratory.

A number of war-time projects at the Dominion Physical Laboratory called for magnets of special design. The technique of casting "Alnico" and "Ticonal" magnets was developed, but it soon became apparent that the existing methods of magnetising would be inadequate for large alnico magnets. The possibility of designing a satisfactory electronic magnetiser was suggested by a brief note in an overseas journal, especially as the method described seemed very suitable for magnetising moving-coil meter magnets, which are usually circular or C-shaped and not easily magnetised by conventional methods.



Front view of the magnetiser. At the bottom right is the single turn secondary winding which performs the actual magnetisation.

The action of the electronic magnetiser depends on the circular field which surrounds a conductor carrying current. Although very large fields, and hence very large currents, are required to magnetise alnico and other modern magnet alloys, it is necessary to maintain these fields for only a relatively short time. These requirements can be met very conveniently, of course, by a capacitor discharge method following the technique of capacitor discharge welding systems and similar processes. If a large condenser bank is charged to a high voltage and then suddenly discharged through the primary of a step-down transformer, very large secondary currents are obtained. This is the principle of the electronic magnetiser.

Theoretical considerations clearly indicate that if a large primary current is to be produced, the condenser capacity involved must be reasonably large and the resistance and equivalent inductance of the discharge circuit must both be as small as possible. The magnitude of the secondary current depends on the rate of change of primary current and transformer turns ratio, while its effectiveness from a magnetising point of view depends on the absence of any appreciable reverse current following the main current pulse. Such a reversal would tend to de-magnetise the magnet to some extent. It was realised at the outset that optimum results would not be obtained by any chance circuit arrangement, but satisfactory performance has been obtained from a circuit which has not been altered greatly since the earliest trials were completed.

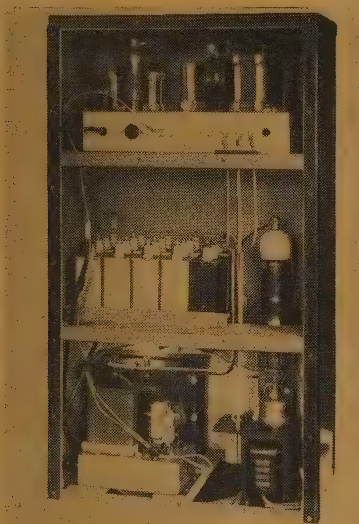
DETAILS OF APPARATUS

The apparatus consists of a 2000-volt D.C. power supply, a 40-microfarad condenser bank, a magnetising transformer, and a thyratron, which acts as a switch in the discharge circuit, with a time duration of 1 milli-second. The power-supply is a conventional 2000-volt supply using an 866-A half-wave rectifier. A current-limiting resistor keeps the charging current within the rating of the power supply, and in effect determines the minimum time that must elapse between discharges. The condenser bank consists of ten paper condensers, each of 4 microfarad, 2000-volt rating. The transformer has a core area of approximately six square inches and a turns ratio of 200 : 1, the secondary being a single turn of ½in. copper bar. Although later information suggests the use of specially-wound primary and secondary to avoid flux-leakage losses, the present model made on conventional lines seems reasonably efficient.

Switching of the primary circuit is performed by a thyratron F.G.41, controlled by means of its grid voltage. This tube has low ionisation time and effective resistance, but it is rather large for the purpose, and in addition an electronic delay circuit (or similar delay) is necessary to prevent damage due to an insufficient "warming-up period." An Ignitron would be more suitable, but none was available in New Zealand at the time. The design of a mechanical switch to withstand the required voltage and current and to

operate with sufficient speed would present difficulties.

The accompanying photographs illustrate the general size and appearance of the unit. The back view shows the power supply at top, the condenser bank at centre, and the time-delay and magnetising transformer at lower left. The thyratron is at the right. The front view shows the construction of the copper secondary of the magnetising transformer, with its removable centre section. A good low resistance joint at this point is essential. The primary and secondary currents were measured and found to be of the order of 200 and 40,000 amperes respectively.



Back view. The equipment in the three chassis is described in the text.

The magnetiser has proved most useful for the re-magnetising of instrument magnets of all sizes. The magnetic circuit must be completed by means of keepers as a small air gap greatly reduces the magnetisation obtained. Special secondary links and keepers enable articles of awkward shape to be magnetised in the correct direction, and a number of loudspeaker manufacturers have found the method very suitable for magnetising permanent magnet speakers after assembly. The model illustrated was made up as a laboratory instrument, and is fulfilling that purpose admirably. One of its most important features is that it can be operated from any 230-volt outlet and its maximum power consumption is approximately 150 watts. The design of a more compact unit for portable use should not present any great difficulties.

Acknowledgment is made of the valuable initial work of Mr. J. Simpson, who began the investigation while at the Radio Development Laboratory, Wellington.

This page is contributed monthly by the New Zealand DX Radio Association (Inc.), 20 Marion Street, C.2, Wellington, New Zealand. All "DX" and Club inquiries should be addressed direct to the Association.

THIS "DX-ING"

STATIONS TO BE HEARD

4860kcs.—New frequency of the Armed Forces Radio Network in Tokyo; signals good from as early as 9.30 p.m. until closing at 2 a.m. with the Star Spangled Banner.

4910kcs.—A new Jap outlet carrying the Home Service programme at 10.15 p.m. in relay with JVW on 7258kcs.

8000kcs.—Official Dutch Station in Bandoeng is heard at 11 p.m. with same programme as on 10060kcs. and 3015kcs.

6130kcs.—A new Norwegian operating from Fredrikstad has been heard at good strength at 9 a.m. in relay with Klofta on 6200kcs.; 10-note interval signal used.

9350kcs.—"Radio Sofia" signals improving in English broadcast at 8.30 a.m. Reports are requested prior to sign-off at 8.40 a.m.

9605kcs.—JLP Japan with A.F.R.S. programme at 8.30 p.m. announcing as the Armed Forces Network.

12116kcs.—"Radio Algerie." Algeria broadcast 5.27 p.m. to 7.45 p.m., 11.45 p.m. to 1.30 a.m., 7.30 a.m. to 9 a.m. On Sunday they transmit 6 a.m. to 8 p.m. in lieu of 5.27-7.45 p.m. Address for

1215kcs.—China, heard opening at 11 p.m.

reports: "L'Ingenieur Chef des Services, Techniques de la Radiodiffusion en Algerie."

11810kcs.—HOXB, Panama, heard testing, due to be on regular transmission on October 1. Address reports to: "Chief Engineer, Box 135, Panama City, Panama." Closes at 3.35 p.m. with National Anthem of Panama.

15100kcs.—HOXA, Panama. Closes at 2 p.m. (see HOXB).

12400kcs.—CS2WI, Portugal, 9 a.m.

10135kcs.—HH3W, Port-au-Prince, Haiti. Closes 3 p.m.

11040kcs.—CSW6, Portugal. Closes 8 a.m.

11090kcs.—Ponta Delgada, Azores. Closes 8 a.m.

9515kcs.—Peru, heard as early as 2 p.m. Slogan is "Radio Emissora Mas Populares"; signs off 5 p.m. daily.

6450kcs.—COHI, Cuba. Closes at 6 p.m. in English and opens at 11.30 p.m. under the call "Radio Cadena Azul."

11960kcs.—HEK4, Switzerland, has English sessions Tuesday and Saturday, 4 p.m.

DX SESSION

On Sunday, September 29, at 1.10 p.m. the New Zealand DX Radio Association was featured in the weekly DX session over Radio Australia (17.84mcs.) in the North American transmission. From reports received from our members throughout New Zealand the broadcast was very poorly received, due no doubt to prevailing conditions. The Club will be featured at a later date, so keep listening.

STATION ADDRESSES

BRITISH HONDURAS:

ZIK-2.—P.O. Box 48, Belize.

CANADA:

CKFX.—543 Seymour Street, Vancouver, British Colombia.

CHTA, CKLO, CKLX, CKCX, CKNC, CHOL, Canadian Broadcasting Corporation, International Service, 1236 Crescent St., Montreal.

CHNX.—The Maritime Broadcasting Co., Ltd., P.O. Box 400, Halifax, Nova Scotia.

CBFW, CBFX, CBFY.—Canadian Broadcasting Corporation, 1231 Catherine Street, Montreal.

CJRC, CJRX.—Transcanada Communications, Winnipeg.

CFRX.—Rogers Radio Corporation, 37 Bloor St., Toronto, Canada.

CFCX.—Canadian Marconi Co., P.O. Box 1690, Montreal.

CBRX.—Canadian Broadcasting Corporation, Vancouver, British Colombia.

COLOMBIA:

HJDE.—"La Voz de Antioquia," c/o L. Ramos, Carrera Junin No. 52-74, Medellin.

HJFH.—"La Voz de Armenia," Carrera 13, No. 19-23, Armenia, Caldas.

HJGF.—"Radio Bucaramanga," Apartado 47, Bucaramanga.

CURACAO:

PJC-1.—Curacao Radio Vereenging, Willemstad.

COSTA RICA:

TIPG.—Apartado 225, San Jose.

TI4NRH.—Apartado 40, Heredia.

TIEP.—Apartado 257, San Jose.

TIGPH.—Apartado 800, San Jose.

CUBA:

COCX.—Reine 314, Altos, Havana, Apartado 32.

COCO.—San Miguel 314, P.O. Box 98, Havana.

COBL.—Apartado 541, Havana.

COK.—"Palacio de Deportes," Secretaria de Educacion, Havana.

COBZ.—"Radio Salas," Apartado 866, Havana.

COKG.—Apartado 137, Santiago de Cuba.

COCW.—"La Voz de las Antilles," Apartado 130, Havana.

COBC.—Apartado 132, Havana.

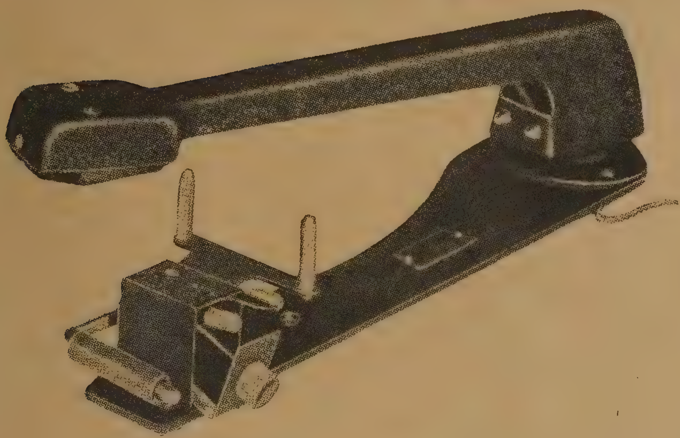
COGF.—Radio Emisoras COGF, Playa 51, Matanzas.

COCH.—Calle B No. 2-Vedado, Havana.

BBC VERIFICATION

DX-er's can now receive a verification of the BBC transmissions. Hayes, local BBC representative, of 8 Althorpe Crescent, New Bradwell, Bletchley, Bucks, England, will verify all reports on BBC transmission provided two Imperial Reply Coupons are enclosed to cover expenses.

The LAST WORD in Pick-ups —
THE LEXINGTON Moving Coil



To ensure faithful translation of the lateral deviations of a record groove into rotary motion in a moving-coil pick-up, it is essential, amongst other things, that the movement should have only one principal degree of freedom. This is achieved in the "Lexington" pick-up by mounting the moving coil between end bearings with "watch-making" clearances. Damping is applied by a rubber pad at the needle holder, which plays no part in the suspension of the coil.

The moving coil is housed in a light plastic tube which has just enough resilience to allow the small vertical movement required by the "pinch effect." Deflection of the centre of the coil in this manner is limited by a ring of increased diameter formed round the centre of the tube; this acts as a stop if the pick-up is accidentally dropped on the record.

Sapphire needles are used with this pick-up. They have morse-tapered shanks fitting a tapered hole in a metal insert in the moving-coil unit; no set screw is required. A shoulder is provided on the needle and a special mechanism is incorporated in the tone-arm rest for removing and inserting needles; both operations are easy as separate locators are provided.

The tone arm itself is light but rigid, and is of pressed and welded aluminium construction. The pivot bearings are well made and consist of single ball joints which give full freedom without any trace of slackness. Needle pressure is controlled by a long leaf spring inside the arm, and a light coil spring is arranged to give the tone arm a lateral bias towards the centre of the record. This is stated to result in a reduction of surface noise. The weight at the needle point is of the order of $\frac{1}{2}$ oz.

The average output is about 1 mv. and the frequency response is stated to be flat from 30 c/s. to 12 kc/s. A coupling transformer giving an output of 50 mv. is available, and also a heavy gauge Mumetal screening box.

SUPPLIES AVAILABLE FROM :—

HOHNER ELECTRICAL CO.

11 HERBERT STREET WELLINGTON

(P.O. Box 192 TE ARO)

THE ZCI MARK II TRANSMITTER-RECEIVER

Since these sets, with all their accessories, have recently become available to the public at what can only be described as a token price, it is felt that a short technical description should be of interest, not only to intending buyers, but also to those who have purchased them.

The ZC1 Mark II was designed and manufactured in New Zealand during the war for use by the Army in a short-range mobile and portable capacity. For this reason, it has a very low power output, but this need not deter intending users. The 2-3 watt carrier is quite capable, when used with an efficient aerial, of working stations over the length and breadth of the country, and with only moderate aerials of allowing short-range working up to 20 or 30 miles.

SUITABILITY FOR AMATEUR USE

The ZC1 Mark II, with no extra equipment at all, could form an excellent low-powered amateur station for mobile or portable work, while, with a very few simple modifications, it can do duty as a fixed station. As a guide to its possibilities, here is a list of specifications.

(1) Transmitter and Receiver Entirely Separate:

In this set, transmitter and receiver are entirely separate. Each employs its own valves, none of which is used in both receiving and transmitting conditions of the set. The transmitter employs five tubes as follows: 6U7-G electron-coupled oscillator, 6U7-G buffer, 6V6-G power amplifier, 6V6-G modulator, 6U7-G speech amplifier, or M.C.W. oscillator.

The receiver is a superheterodyne comprising the following tubes: 6U7-G R.F. amplifier, 6K8-G oscillator-mixer, 6U7-G I.F. amplifier, 6Q7-GT second detector, A.V.C. and first audio, 6U7-G (triode-connected) second audio, 6U7-G B.F.O.

Front-panel switching enables the transmitter to be switched off entirely, leaving only the receiver running, or the transmitter filaments to be lit on the standby position.

(2) Frequency Coverage and Tuning:

Transmitter and receiver each cover the same frequency range of 1.9 to 8 mc/sec. in two bands. Single control, ganged tuning is provided for the transmitter as well as for the receiver, making tuning of the former particularly easy. Spot frequency working is further facilitated by the provision of two click-stop positions for both receiver and transmitter. These stops may be set to any position on the dial, so that any two frequencies can be pre-set and rapidly tuned thereafter.

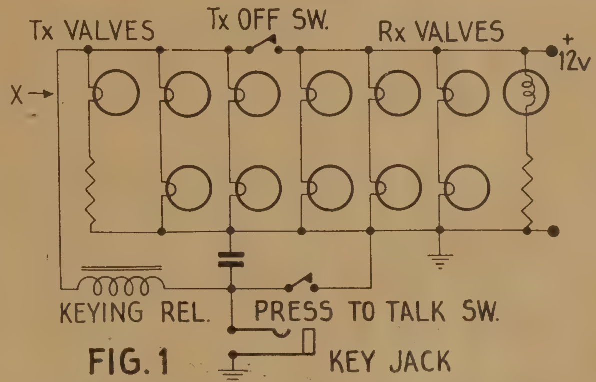


FIG. 1

Original heater and keying relay circuit used in the ZC1.

(3) Aerial Arrangements:

The set is so arranged that a single aerial is used for both transmitter and receiver. No provision is made for using balanced two-wire feeders. This is because the outfit was originally designed for working only with vertical aerials, from short "whips" to quarter-wave inverted L and T Marconi antennas. For this reason also, a comprehensive system of aerial tuning is used, which allows short aerials to be loaded to the point where they will draw power from the final tanks. As an aid to aerial tuning, a built-in meter is used to measure the final plate current. This same meter, by means of a push-button is used to measure the battery voltage.

If it is desired to use the ZC1 as a fixed station, feeding a horizontal half-wave aerial through tuned or untuned feeders, it would be a comparatively simple matter to replace the existing aerial coupling device by a link feeding out to an aerial tank circuit in the usual way.

(4) Power Supply:

Since the set was designed for mobile and portable work, it is arranged to obtain both filament and H.T. voltages from a 12-volt accumulator. H.T. voltage is produced by a synchronous self-rectifying vibrator circuit, whose transformer, smoothing choke and hash filter are built into the set. The set therefore, forms an ideal reserve transmitter and receiver for emergency working, or for work when power shut-downs are in operation.

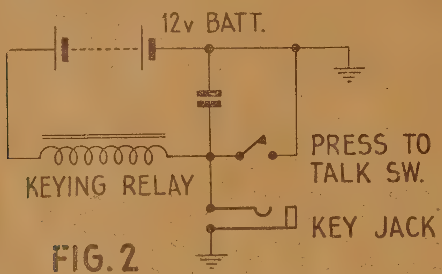


FIG. 2

The keying relay circuit as it should be operated by a battery (or metal rectifier) if the ZC1 is modified for use off the A.C. mains.

Battery consumption under various conditions of switching is as follows:—

Receive (Tx heaters off)	2.8 amps.
Receive (Tx heaters on)	3.8 amps.
Send (C.W.)	4.4 amps.
Send (R.T. or M.C.W.)	4.9 amps.

A 12-volt 85-ampere-hour battery can be expected to operate the set under normal conditions for 21 hours on C.W. and for 20 hours on R.T. or M.C.W.

These figures are based on the assumption that on "send" the key is down for one-third of the total time.

THE TRANSMITTER

The circuits of the transmitter are quite conventional, except for the ganging of controls already mentioned, and for the use of resistance capacity coupling between the oscillator plate and buffer grid circuits. The apparent complication that can be observed on the full circuit diagram arises solely from the switching which is employed to enable different functions to come into use. The keying circuit exemplifies this admirably. When the "R.T. C.W. M.C.W." switch is in the C.W. position, the keying relay works a three-pole double-throw switching arrangement as follows: With the key up, the transmitter aerial circuit is grounded, the aerial is connected through to the receiver input and a negative blocking voltage is applied to the grids of the transmitter valves. When the key is down, the keying relay is closed. This switches the aerial from receiver to transmitter, open-circuits the cathodes of the R.F. mixer and I.F. stages in the receiver and grounds the "high" end of the R.F. stage tuned circuit, in addition to removing the blocking bias from the transmitter tubes.

When operating on R.T., the functions performed by the key in the C.W. position are taken over by the microphone switch, thus allowing break-in operation on R.T. as well as on C.W.

THE RECEIVER

This is a six-valve superhet., with the line-up detailed above. Its controls, in addition to main tuning and band-switch, are: aerial tuning control, gain control, and B.F.O. pitch control. A noteworthy point is that the wave-change switches of transmitter and receiver are separate. This allows completely independent working of the two units. There is also a noise reduction filter, working directly on the audio output, which can be switched in or out at will. This filter consists of four "Westector" metal rectifiers connected in pairs, "back to back" across the secondary of the output transformer. The rectifiers have little or no effect on normal speech currents, but conduct heavily on high amplitude pulses such as are produced by ignition noise, etc., limiting their amplitude to little more than that of the desired audio signal.

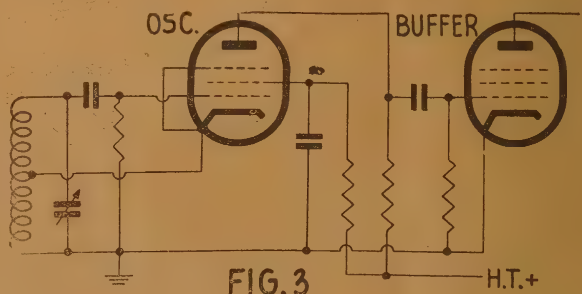


FIG. 3

The original oscillator-buffer circuit as used in the ZC1. Band switching arrangements have been omitted for the sake of clarity.

In the second-detector-A.V.C.-circuit, there is a rather complicated system of switching, which functions at the turning of the R.T.-C.W.-M.C.W. switch. On the R.T. position, A.V.C. is applied to the R.F. and I.F. stages, and audio gain control takes place in the grid circuit of the 6Q7-G. In the C.W. and M.C.W. positions, A.V.C. is disconnected and the gain control is switched in such a way that it becomes an R.F.

gain control, feeding a variable negative voltage to the R.F. and I.F. stages via what was the A.V.C. line.

CIRCUIT MODIFICATIONS

Although the ZC1 as it stands is admirably suited for some amateur requirements, some will probably wish to make certain modifications, more especially to the transmitter. In spite of the rather complex switching circuits, such things as the provision of an A.C. operated power supply, or of crystal control can be very readily accomplished.

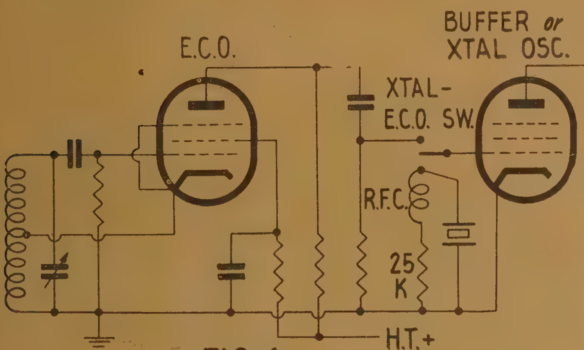


FIG. 4

One method of providing Xtal control, while retaining the E.C.O. for optional use. The Xtal/E.C.O. switch, crystal, R.F.C. and 25k. resistor are the only additional components required.

A.C. OPERATION

If it is desired to convert the set permanently for A.C. operation, it should be a comparatively simple matter to have the transformer rewound, and to substitute a rectifier for the synchronous vibrator. Since the total power requirement during transmission is not greater than 60 watts, the vibrator-transformer core should be of ample size to provide both heater windings and an H.T. winding of 300-0-300 volts at 80 to 100 ma. A single 6.3v. winding at 5 amps. would be sufficient for all heaters, including two 6X5-GT rectifiers used in a full-wave rectifier circuit.

The existing heater circuit is shown in Fig. 1, and is a simple series-parallel arrangement. Since there is an odd number of valves, one of them (the speech amplifier tube) has a resistor in series with it. All that would have to be done to operate the heaters on A.C. would be to unsolder the existing wiring and connect all heaters in parallel. The switch shown enables the transmitting tubes to have their heaters turned off independently of the receiver, so as to conserve battery power when the receiver is being used for listening only. If A.C. operation is contemplated, there is little point in having this facility, so that the switch could well be cut out of the circuit.

Also shown on Fig. 1 are the keying relay, the key-jack, and the press-to-talk switches. If the set is powered by A.C., the latter circuit will have to be broken at the point x, and a separate 12-volt battery provided for operating the keying relay. Since the drain is intermittent, and not very heavy, dry batteries would be quite satisfactory for this service, and would be inserted as shown in Fig. 2. In this way, the keying system will be able to function exactly as before.

If it is desired to retain the existing power supply, and yet use the A.C. mains as an alternative, a transformer and metal rectifier delivering 12 volts at 5 amps. can be used to replace the battery, no changes being made to the set itself. It is believed that one firm in Wellington is already producing such a power unit.

PROVISION OF CRYSTAL CONTROL

Amateurs who might prefer to operate the transmitter on crystal control can do so by means of either of two simple modifications. However, it should be mentioned here that the transmitter is exceptionally stable for a self-excited one, and

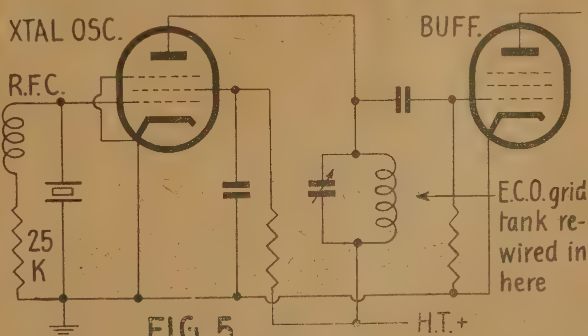


FIG. 5

An alternative, but not so flexible, method of providing Xtal control. The tank circuit shown in the oscillator plate is that originally used in the E.C.O. grid circuit, re-wired as shown.

compares favourably as far as note is concerned with a crystal-controlled job.

The existing oscillator and buffer input circuits are shown in Fig. 3, while in Fig. 4 is shown a very simple method of installing crystal control and, at the same time retaining the E.C.O. for use if desired. The switch can be mounted conveniently on one of the shield partitions as can the crystal holder. As can be seen from the circuit, the oscillator valve is unused when on

(*Continued on page 48.*)

TUBE DATA

TYPE EF39 R.F. PENTODE

General:

The EF39 is the octal-base equivalent of the EF9 to which in all other respects it is similar. Fig. 1 shows the EF39 dimensions and socket connections.

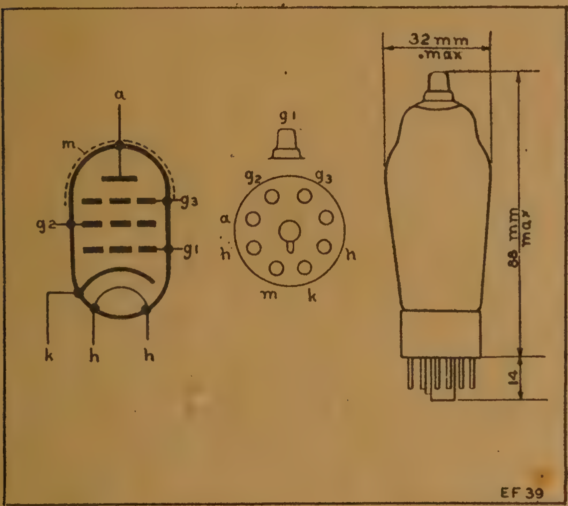


Fig. 1.

The tube has a variable mu characteristic and was originally designed specially for use in the final I.F. stage of superheterodyne receivers. However, its excellent characteristics make it eminently suitable for I.F. or R.F. amplification in any receiver.

Mutual Conductance:

The mutual conductance of the EF39 is 2.2 ma./v. at its minimum bias of − 2.5 volts. This is quite high, being 34 per cent. higher than that of one of the most commonly used super-control R.F. pentodes. This means that, other things being equal, it can give 34 per cent. more gain in a particular stage.

Use as a Replacement:

In some cases the advantages of higher gain and better large-signal performance can be obtained by substituting an EF39 for a 6K7 or 6U7-G. Such replacement is possible because the base connections of the EF39 are identical with those of the other two types mentioned. However, such replacement might not always meet with success because the increased gain of the EF39 may cause oscillation in a circuit which was stable with a 6K7 in the socket. The question of replacement has been mentioned here, since at least one New Zealand manufacturer has signified that sets originally designed for the 6K7 may be found with an EF39 in the 6K7 socket, owing to supply difficulties.

Screen Voltage Supply:

It is important to note that the EF39 was designed to be used with a dropping-resistor for supplying screen voltage, rather than a voltage divider. Although it will function quite satis-

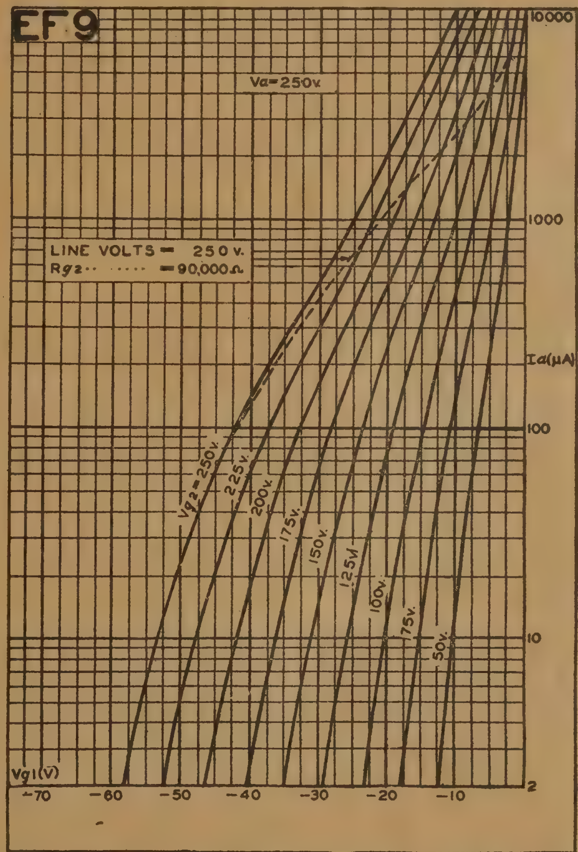


Fig. 2. Plate current in microamps, against grid voltage for various screen supply voltages. A screen dropping resistor of 90,000 ohms is used in all cases. The dotted curve is for a fixed screen voltage of 100 volts.

factorily in circuits which employ the latter scheme of obtaining screen voltage, *full advantage of the design of the EF39 is obtained only by the use of a dropping resistor.* The reason for this

ELECTRICAL DATA

1. **HEATER:** Indirect heating A.C. or D.C.

Heater voltage	6.3 v.
Heater current	0.2 amps.

2. **CAPACITIES:**

C(g — p.)	0.002 $\mu\mu f$.
C(g — cath.)	5.5 $\mu\mu f$.
C(p — cath.)	7.2 $\mu\mu f$.

3. **OPERATING CHARACTERISTICS AS I.F. OR R.F. AMPLIFIER:**

(a) 250v. Supply.

Plate voltage		250v.	
Screen supply resistor		90,000 ohms	
Suppressor voltage		0v.	
Cathode resistor		325 ohms	
Min. grid bias	— 2.5v.		
Grid bias for decrease of 40 db. in gain ..		— 39v.	
Grid bias for maximum control			— 49v.
Screen voltage	100v.		
Plate current	6 ma.	170 μa.	28 μa.
Screen current	1.7 ma.		
Amplification factor	2750		
Mutual conductance	2.2 ma./v.	22 μa/v.	4.5 μa/v.
Plate resistance	1.25 meg.	10 meg.	10 meg.

(b) 100v. Supply.

Plate voltage		100v.	
Screen supply (fixed)		100v.	
Suppressor voltage		0v.	
Cathode resistor		325 ohms	
Min. negative grid bias	— 2.5v.		
Grid bias for decrease of gain of 40 db. ..		— 16v.	
Grid bias for maximum control			— 19v.
Plate current	6 m.a.	70 μa.	17 μa.
Screen current	1.7 ma.		
Amplification factor	880		
Mutual conductance	2.2 ma./v.	22 μa/v.	7 μa/v.
Plate resistance	0.4 meg.	10 meg.	10 meg.

is that the EF39's design renders it more successful in handling large signal voltages without excessive distortion than any previous variable mu pentode. This fact and the tube's high mutual conductance are the two main points in its favour.

Thus, if the EF39 is used as an R.F. amplifier, or as the 1st I.F. stage in a receiver which has more than one I.F. stage, it is immaterial whether a voltage divider or a dropping resistor is used. However, when the tube is used as the sole or final I.F. stage, it is advisable to use a dropping resistor.

Special Design Feature:

The special design feature of the EF39 which gives it the advantage of low distortion and cross modulation effect, is the fact that, as its screen voltage is increased, so its mutual conductance decreases. This has the effect of straightening out the high-bias portion of the Ia-Vg curve. It is not possible for this portion of the curve to be quite straight, so that, with large signal voltages applied, a certain amount of cross-modulation and non-linear distortion must be expected, as with any variable mu valve, but in this case these undesirable effects are greatly reduced.

It can be seen from the above that, if the benefit of the decrease of mutual conductance with increase of screen-voltage is to be fully realised, some method must be found of automatically raising the screen voltage when large

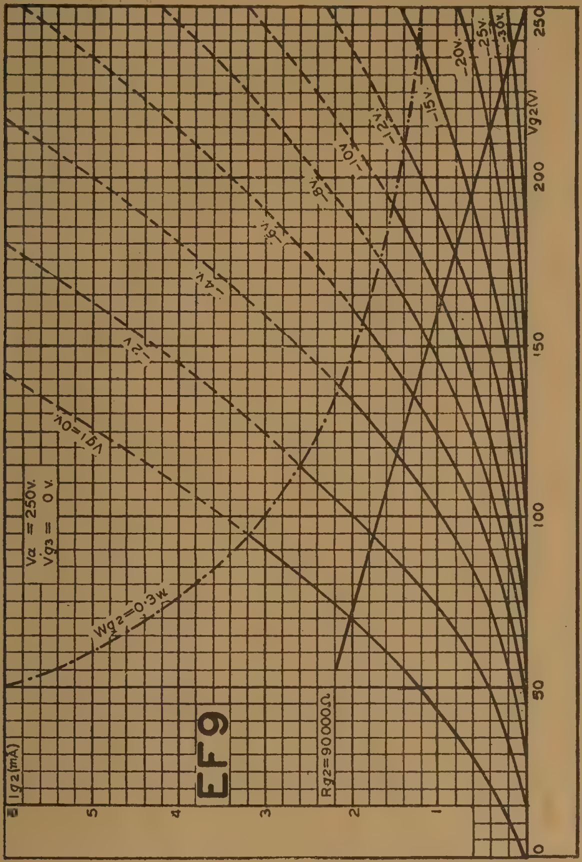


Fig. 3. Screen current in milliamps against screen voltage, for various values of grid voltage. Also shown is the load line for a screen dropping resistor of 90,000 ohms and a plate and screen supply voltage of 250 volts. Intersections of the load line with the curves show the screen current and voltage at the values of grid vias shown. The dotted portions of the curves show the region where the maximum allowable screen dissipation of 0.3 watt is exceeded.

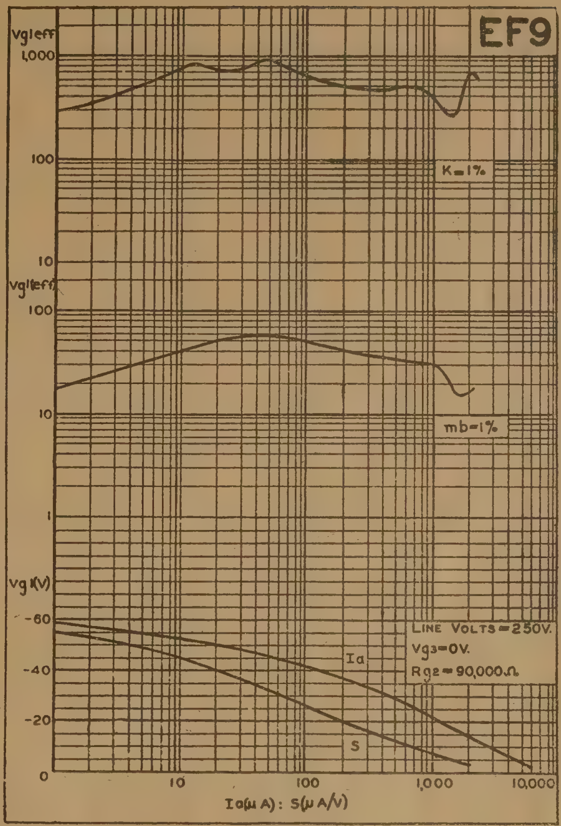


Fig. 4. Top curves show the signal voltage in millivolts that can be applied to the grid of an EF39 for 1% cross-modulation, K, and the hum voltage in millivolts that can be applied to the grid for 1% hum modulation of the R.F. signal. Each of these is shown against mutual conductance S, in microamps per volt. The lower curves show the variation of mutual conductance and plate current with negative grid voltage.

signals are being handled. This is done very easily by supplying the screen from a dropping resistor. Thus, when A.V.C. bias is applied to the EF39 grid, the plate and screen currents decrease. This decrease in screen current causes a decrease in voltage drop across the screen feed resistor, which, in turn, results in a rise of screen voltage. If the screen is fed instead from a voltage divider circuit, the desired rise of screen voltage with increasing A.V.C. bias does not occur.

High Frequency Performance:

At high frequencies the performance of the EF39 is excellent. At 15 mc/sec. the input resistance is 110,000 ohms, dropping to 7,000 ohms at 60 mc/sec., which figures compare very favourably with those for other valves at these frequencies.

FOR THE SERVICEMAN

We know that many radio service shops are justly proud of the efficient and workman-like layout of their test benches, and that interchange of ideas can be beneficial to all concerned. We therefore invite those who have good photographs of their service department to submit them to us so that we may use them for publication in our service page. We also suggest that the photographs be accompanied by a short technical description of the test equipment with particular reference to any new ideas.

THE EDITORS.

'RADIO and ELECTRONICS'

Back numbers of this journal may be obtained from S.O.S. Radio Service, 283 Queen Street, Auckland, and the Te Aro Book Depot, Ltd., 64 Courtenay Place, Wellington, C.3.

THE RADEL "PROGRESSIVE" BATTERY THREE

PART IV: THE FINAL STAGE

The final stage in the construction of the Progressive Three is that of converting it to loudspeaker operation. In order to do this, the 1D8-GT is removed from the detector socket and placed in the hole at the back of the chassis which was designed for the purpose. The 1D8 is now wired up as two stages of audio amplification, resistance coupled, and a 1N5-GT, connected as a triode, is used in the detector socket. We thus have three valves giving four-valve performance, owing to the dual nature of the 1D8.

THE CIRCUIT

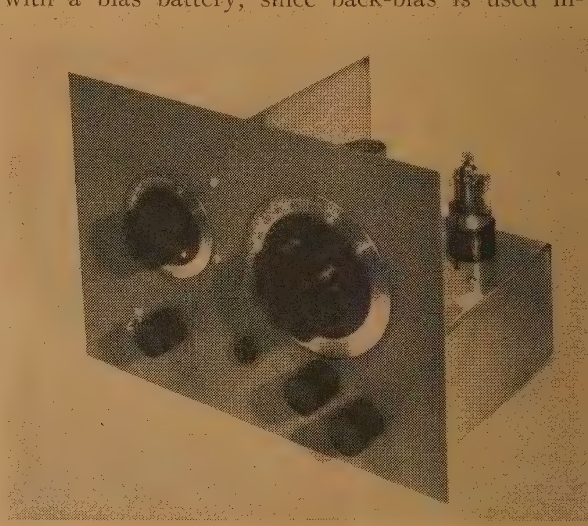
A glance at the final circuit shows that, apart from the substitution of the 1N5 in the detector socket, the circuit from the aerial to the output of the detector is substantially unchanged. About the only differences which can be noted here are (1) the addition of an R.F. gain control, and (2) the addition of the de-coupling filter R_4 C_7 in the detector H.T. lead. The first of these additions is necessary because the set is now powered from 90 volts of B battery, and this R.F. gain control may be necessary in some locations to prevent overloading by local stations on the broadcast band.

Although de-tuning the R.F. tuned circuit can be used as a means of reducing the R.F. gain, this may not always be practical, as it may increase the set's response to an unwanted station on a nearby frequency. The R.F. gain control is therefore a very useful adjunct, and adds considerably to the flexibility of the set. On weak signals, however, it will always be used at maximum.

In addition to inserting R_4 and C_7, the value of the detector plate resistor has been increased also, because of the increased battery voltage. This saves taking out an extra lead to the +45 volt tapping on the battery.

It is rather unusual to see the audio volume control R_{11} placed in the detector plate circuit, rather than in the grid circuit of the first audio stage. However, this has to be done in this case to allow the triode section of the 1D8 to be run with grid-leak bias. The value of R_3 is 10 megohms, and potentiometers of this high value are unobtainable. The one disadvantage of this circuit is that R_{11} may make some noise when it is moved, but this is unavoidable, and is a small price to pay for the convenience of having no C bias battery to buy and to replace when worn out.

The power output stage uses the pentode section of the 1D8 and is also able to dispense with a bias battery, since back-bias is used in-



The completed "Progressive Three." The dial on the right is the detector tuning, while the smaller one on the left is the R.F. tuning control. The knobs from left to right are: R.F. gain, regeneration control, and audio gain. In the centre is the 'phone jack, and on the extreme left the on/off switch.

stead. It can be seen that the negative terminal of the B battery is not connected to the chassis, but to one end of R_7, whose other end is taken to the chassis. Thus, the plate current of all three valves flows through R_7 in such a way as to make the unearthed end negative with respect to the chassis. This negative voltage (approximately 9 volts) is used as bias for the output stage by connecting to it the bottom end of the pentode's grid resistor.

The headphone jack is now connected across the primary of the output transformer, and the switch SW_2 is mounted on the back of the chassis next to the speaker socket. This switch is used to disconnect the speaker transformer from the output stage when the phones are in use. In

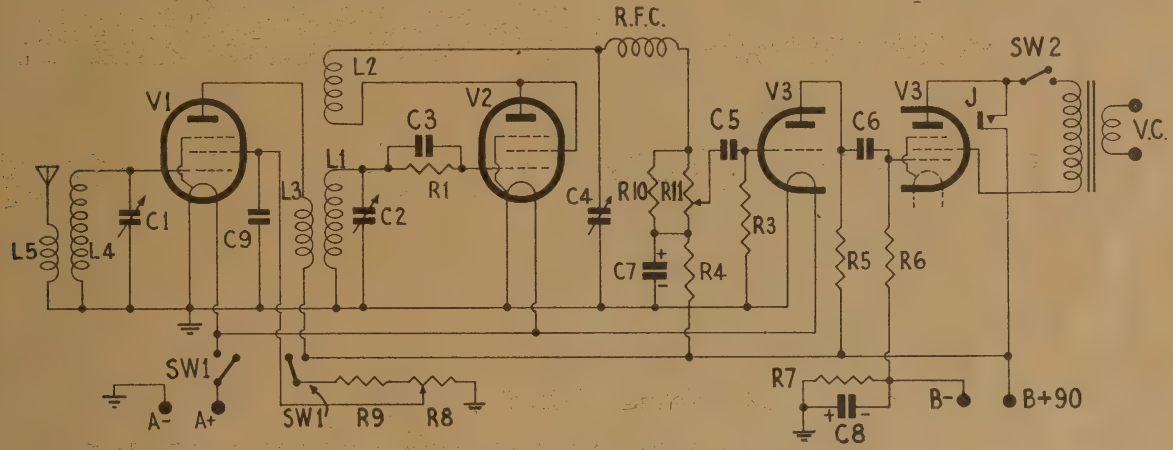
using the phone jack and speaker switch, care should be taken that either the phones or the speaker are in circuit if the set is turned on. If this precaution is not taken, the pentode section of the 1D8 will operate with screen voltage applied, but no plate voltage, and this is very likely to damage the tube.

Another point to be mentioned is that of the on/off switch SW_1. This is now a double pole on/off switch, one section of which is used to turn off the filaments, and the other to remove the battery voltage from the screen voltage-divider R_9 and R_8. If this is not done, the B battery will slowly discharge through these resistors, even when the set is turned off.

Note carefully also the way in which C_8 is connected across R_7, i.e., with the positive terminal to the chassis and the negative one to B—. Connecting this condenser the wrong way round will ruin it in quite a short time, even though the voltage across it is quite low.

If the set has been built progressively as we suggested in Part I of the story, you will have become fairly familiar by now with the operation of the set, so there should be no need to say anything about this side of the matter. With the set completed as here it will not only give world-wide DX reception, but also room volume on even quite weak shortwave stations.

The use of headphones need only be resorted to in the case of extra-weak distant stations, or where other people in the room do not like the noise.



NOTE.—For coil data see Part III of this series.

$R_1 = 2$ meg.
$R_3 = 10$ meg.
$R_4 = 25$k.
$R_5 = 100$k.
$R_6 = 0.5$ meg.
$R_7 = 1.5$k.
$R_8 = 50$k. pot.
$R_9 = 10$k.
$R_{10} = 50$k.
$R_{11} = 100$k. pot.
C_1, $C_2 = 0.00035\mu f$. max. variable.
$C_3 = 0.0001\mu f$.
$C_4 = 0.0003\mu f$. max. variable.
$C_5 = 0.01\mu f$.
C_6, $C_9 = 0.1\mu f$.
$C_7 = 8\mu f$. electro.
$C_8 = 25\mu f$. 25v. electro.
SW_1 = Double-pole on/off.
SW_2 = Single-pole on/off.
R.F.C. = 2.5 mh. choke.
J = Open cct. 'phone jack.
V_1, V_2 = 1N5-GT or 1P5-GT.
V_3 = 1D8-GT.

Output Transformer = 12,000 ohms—voice coil.

Having been connected with radio sets of all sorts for quite a long time, we thought we were fairly hard-boiled in the matter of getting a "kick" out of reception from small battery sets, but when we had finished building the "Progressive Three" we found we were not quite as blasé as we thought. Reception from all over the world on the little set was really first class, and better than that of a good many more pretentious sets we have heard. If our readers get as much fun out of building it as we did, then we will be very pleased indeed. We will be even more pleased if readers who have built it write to us and let us know how it performs for them.

QUESTIONS and ANSWERS

Mr. H. E. Wills, Invercargill, writes: "I have a 500-ohm line connected at one end to an output-to-500-ohm transformer and at the other to a 500-ohm-to-voice coil transformer. Is the load reflected back to the output tubes going to change if I connect another 500-ohm-to-voice coil transformer across the line? For example, if a total of five such transformers were connected across the line, would the impedance to be matched to the valves be 100 ohms, or would it remain at 500 ohms?"

If extra 500-ohm speaker transformers are connected across the line, the impedance to be matched to the tubes will be 500 ohms divided by the number of transformers. The speaker transformers can each be regarded as having an impedance of 500 ohms on the primary side, so that, just as with resistors, if the primaries are connected in parallel, the total impedance can be found from the formula

$$\frac{1}{Z} = \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3}$$

Thus, if five similar 500-ohm transformers are connected in parallel, the resulting impedance will be one-fifth of 500 ohms = 100 ohms. Then, in order to match this to the valves, the plate-to-line transformer would have to match the required plate load impedance of the valves to an impedance of 100 ohms. If it is then desired to turn some speakers off, it is necessary to insert a 500-ohm resistor in place of the disconnected transformer, if the valve matching is not to be upset.

* * *

Mr. P. H. Carman, Lake Coleridge, writes that he is experiencing trouble with oscillation in an infinite impedance detector which he is using as the second detector in a superhet. with 450 kc/sec. I.F. He gives the circuit, and shows that, instead of taking the plate of the detector tube directly to H.T., he has inserted an R.F. choke in this lead, and is using the R.F. developed at the plate to feed the A.V.C. diode. Mr. Carman asks: "Would a damping resistance of 25k. across the I.F. transformer secondary cure the instability, or, alternatively, would a grid stopper be necessary?"

The oscillation could probably be cured in either of these two ways, but neither is a very satisfactory solution, as it does not remove the cause of the instability. The reason for this is the insertion of the R.F. choke in the plate lead, giving oscillation due to feed-back through the grid-plate capacity of the tube, similarly to any unneutralised triode R.F. amplifier. The best plan is to remove the choke and to feed the A.V.C. diode from the primary side of the last I.F. transformer through a small condenser (say 100$\mu\mu f$.).

CAN I USE A ZC1?

There is no doubt whatever that any person **can** use a ZC1, but it is emphasised that, unless the individual concerned is a certificated operator, and is the holder of a radio station license, he definitely may not.

Several important factors surround the sale by W.A.R.B. of the surplus ZC1 radio telephone sets. In the first place, the equipment is being sold at only a small fraction of its original cost, and this point alone is an invitation to set up a radio telephone service for various purposes which hitherto has been impossible or uneconomical on account of the high price of the necessary equipment.

The ZC1 can be put to many uses. One which immediately comes to mind is its use on small ships and pleasure craft. This aspect obviously is governed by P. and T. regulations, and it is strongly recommended that any proposed service utilising a ZC1, or some similar apparatus, should be submitted to the Post and Telegraph Department for the necessary authorisation and frequency allocation.

While the Post and Telegraph policy is broad, the frequency channels are not. Consideration must be given to the frequencies necessary for the ultimate introduction of navigational aids, telecommunications, D.F., ship to shore, emergency communications and broadcast services. These and many more in addition to the services already in use, constitute a formidable list. With the exception of the ultra-high-frequency bands, therefore, the usable communication spectrum is overcrowded. Thus, it is necessary to design an R.T. set around the allocated frequency, rather than allocate a frequency to suit the available equipment.

While it is not within the province of "Radio and Electronics" to set itself up as an authority on Post and Telegraph regulations, it must be obvious to all that a license to operate a ZC1 on any band, other than the amateur ones, will be granted only after serious consideration has been given to the circumstances and merits of the particular case. In some cases, it will be necessary to modify the ZC1 to make it crystal controlled, whilst in others, the transmitter frequency controls must be pre-set. In all cases the equipment must be operated by a qualified operator—the grade of certificate being governed by the requirements of the particular service involved.

Summarising—take our suggestions seriously, and, if you are contemplating a radio telephone service, see your local radio inspector first.

DESIGN SHEET No. 3

The Design of Vented Loud-speaker Enclosure

For many years a difficult problem in connection with sound reproduction has been that of providing an adequate baffle for dynamic loud-speakers. A theoretically desirable baffle is a very large flat sheet of rigid, non-vibrating material, near the centre of which the speaker is mounted, but the flat baffle, as it is called, takes up a great deal of space, and is therefore quite impracticable for many applications.

Perhaps the best of the many baffles which have been designed in attempts to overcome this space difficulty is the so-called vented baffle, or bass reflex enclosure. It is very simple to construct, gives even better results than a large flat baffle, and takes up no more room than the average console radio cabinet, so that, for many purposes, and particularly for home use where space is always at a premium, the vented baffle is an ideal solution.

The vented baffle consists only of a box made of some rigid material, such as heavy wood, and completely enclosed except for the hole in which the speaker is mounted and an additional hole forming the vent referred to in its name.

The important characteristics of the baffle are its internal volume (in cubic feet) and the area of the vent, both considered in relation to the mechanical characteristics of the loud-speaker unit used with it. The properties of the speaker which must be taken into account are:—

(1) The radius of the working part of the cone; and

(2) The low frequency at which the cone resonates.

This chart has accordingly been prepared to enable vented baffles to be designed with a knowledge of these two properties of the loud-speaker.

The cone-radius referred to is the radius to the edge of the conical portion, and should not be measured to the outside edge of the paper. This is because the only portion of the cone used to produce the sound is the conical portion, the flat or corrugated piece outside of this being used purely as a support for the cone proper.

BASS RESONANT FREQUENCY

When the cone of a speaker is tapped, a note is heard which corresponds to the free resonant frequency of the cone. However, this is **not** the resonant frequency required in the design of the vented enclosure. The resonant frequency required is that of the cone when the field is excited, and when the speaker is attached to a large flat baffle.

This frequency will have to be found either by measurement or by reference to the manufacturer of the speaker.

HOW TO USE THE DESIGN SHEET

First of all, measure the radius of the cone, as defined above, in inches. Secondly, measure or obtain from the manufacturers, the bass resonant frequency of the speaker to be used. At this stage the internal volume of the box may be found from the graph. This is used as follows:—Find the radius value on the vertical scale, and travel horizontally until the curve is met which corresponds to the bass resonant frequency. Then, travel vertically to the volume scale and read off the volume of the baffle in cubic feet.

Example: The cone radius is 3 in. and the bass resonant frequency 90 c/sec. What should be the volume of the baffle box? Answer: 2.6 cubic feet.

SUBSEQUENT DESIGN

Having found the required volume, the shape of the baffle, within limits, may be chosen to suit the size of cabinet into which it is to fit, or to give a pleasing appearance. Fig. 1 shows a typical baffle whose internal dimensions are a, b and c feet respectively. If the baffle is to be visible, it is a good plan to make b about 1.4 times a. Thus, suppose in the example above, the width "a" was fixed at 18 in. or 1½ feet. Then the height "b" would be

$$1.4 \times 1.5 = 2.1 \text{ feet.}$$

Now, since two of the three dimensions have been fixed, the third side must be decided, since the volume is known from the chart. The depth therefore can be found from the relation

$$c = \frac{V}{a \times b} = \frac{2.6}{1.5 \times 2.1} = 0.83 \text{ feet.}$$

Thus, the final dimensions of the baffle in the example are: 1.5 ft. × 2.1 ft. × 0.83 ft., or 18 in. × 25 in. × 10 in.

SIZE OF VENT

The remaining step is to decide on the size, shape and position of the vent or hole. The rule which fixes the size of the hole is that **it must be equal in area to the size of the working part of the cone.** We have already measured the radius of the working part of the cone in order to apply it to the chart. Its area is therefore πR^2 sq. in. or $3.14R^2$ sq. in. This is also the area of the vent. In the example given, the cone radius was 3 inches, so that its area is 28.26 sq. inches. The shape of the vent is not very important, but for best appearance a rectangular hole placed under the speaker is desirable. Thus, a rectangular hole 7 in. × 4 in. would be quite satisfactory.

PLACEMENT OF VENT

The vent should be placed as near as possible to the speaker. That is to say, any convenient distance may be used between the bottom of the speaker hole and the top of the vent as long as they are not too far apart. The proportions shown in the diagram Fig. 2 are quite suitable.

OTHER POINTS

For best results, the baffle should be lined with sound-absorbing material so as to prevent multiple reflections occurring within the box at the higher audio frequencies. Some soft material, such as wadding, may be used, held in place with glue. This will not affect the low frequency performance of the baffle, and can be disregarded in calculating the volume of the box.

In specifying the volume of the box, no account has been taken of the space occupied by the speaker itself. It is as well, especially with bulky speakers, to estimate the volume occupied by the speaker and to add this to the volume obtained from the design sheet, but no great harm will come from neglecting this factor with most speaker units.

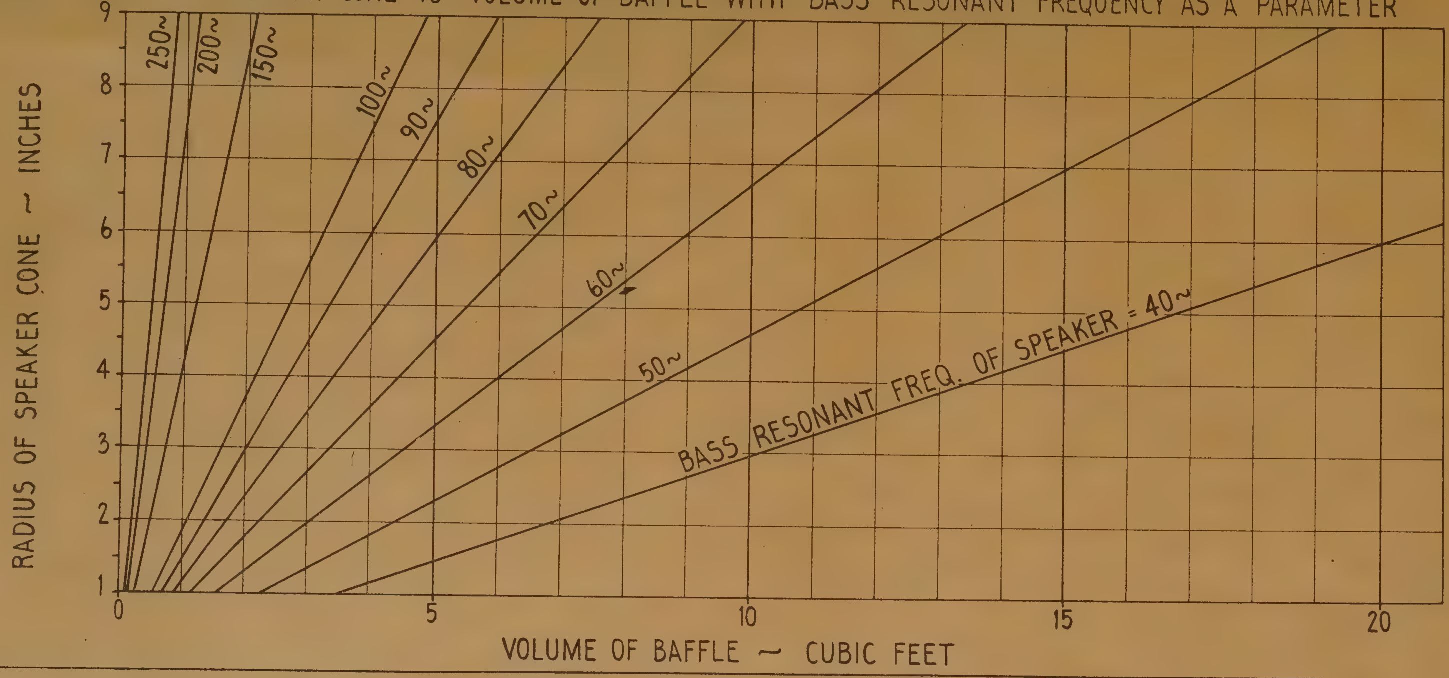
PERFORMANCE OF THE BAFFLE

The action of such baffles has been described frequently in the literature. Briefly, the basis of the design is that the resonant frequency of the air mass contained in the box should equal that of the loud-speaker cone. If this is achieved, the effect on the low-frequency performance of the speaker is somewhat as in Fig. 1. The box greatly reduces the bass

(Continued on next page.)

DESIGN SHEET No3 :- SIZES OF BASS REFLEX (VENTED) BAFFLES

EFFECTIVE RADIUS OF SPEAKER CONE *vs* VOLUME OF BAFFLE WITH BASS RESONANT FREQUENCY AS A PARAMETER



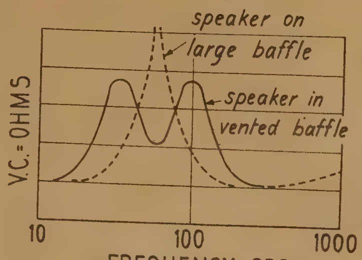


FIG. 2

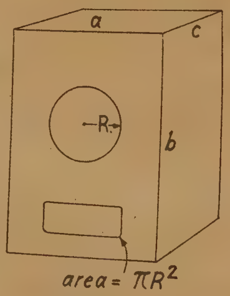


FIG. 1

(Continued from previous page.)

resonance of the speaker, by adequately loading it at this frequency, and instead produces two peaks in the impedance curve, one slightly higher in frequency, and one slightly lower than the original speaker resonance. Quality of bass reproduction is improved because of (1) the reduction in amplitude of the resonant rise, (2) the extension of the low frequency response of the speaker, and (3) the fact that the vent acts in such a way that the low frequency energy radiated from the back of the cone is projected from the vent in phase with that from the front of the cone, thereby increasing again the low frequency output of the combination when compared with the same speaker unit used on a conventional flat baffle.

MEASUREMENT OF FREQUENCY

PART IV

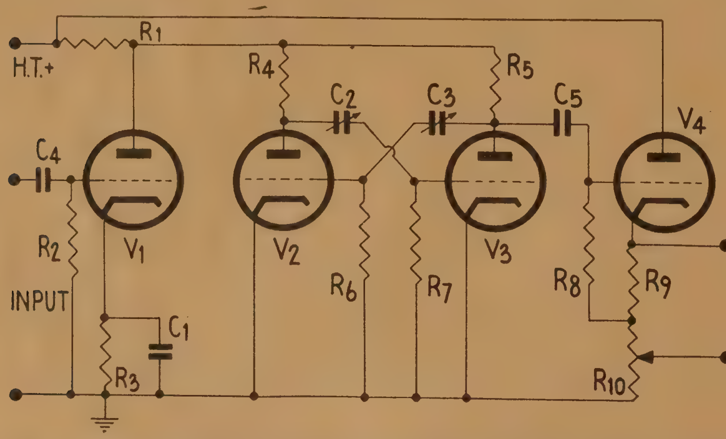
In Part III of this series, which appeared in an earlier issue of *Radio and Electronics,* the construction of a secondary frequency standard was described. This consisted of a very stable 1000 kc/sec. oscillator, a cathode follower buffer stage, and a 6AC7/1852 used as a harmonic generator. The technique was described of setting the oscillator exactly to its nominal frequency by means of the 5 or 10 mc/sec. transmissions of WWV. At the close of the article a description was commenced of the case where the standard is used to calibrate an all-wave oscillator. The latter was presumed to have the following frequency ranges:—500-1500 kc/sec., 1500-4500 kc/sec., 4500-13500 kc/sec., and 9000-27000 kc/sec. The calibration of the 500-1500 kc/sec. range was described showing how this could be effected by the use of known broadcast stations, the standard being used as a check of the 1000 kc/sec. point and the 500 kc/sec. point.

The narrrative is now taken up at the point where the next highest range—1500-4500 kc/sec. —is to be calibrated.

(2) The 1500-4500 kc/sec. Band.

On this band three points can be checked with the secondary standard, viz., 2000, 3000 and 4000 kc/sec. calibration points. Since three points only are not enough to enable a calibration curve to be drawn, the harmonic method may be used to obtain further points on the curve. For instance, to get the 2500 kc/sec. point, we proceed as follows:

The receiver is tuned to 5 mc/sec., where this frequency from the standard will be picked up. The signal generator is then tuned backwards and forwards about the point where 2500 kc/sec. is expected to be until its 2nd harmonic is heard to beat with the standard. Zero-beat adjustment is made, and the signal-generator reading is taken. In the same way, the 3500 kc/sec. point may be found by tuning the receiver to 7 mc/sec., and the 4500 kc/sec. point at 9 mc/sec. on the receiver.



COMPONENT LIST

V_1, V_4 = 6J5 or ½ 6SN7.
$V_2 + V_3$ = 6SN7.
R_1, R_3 = 2k.
R_4, R_5 = 25k.
R_6, R_7 = 100k.
R_2 = 500k.
R_8 = 1 meg.
R_9 = 500 ω
R_{10} = 50k. pot.
C_1 = 0.01 μf.
C_2, C_3 = 3-30 $\mu\mu f$. air trimmer.
C_4, C_5 = 100 $\mu\mu f$. mica.

Additional circuits required to provide signals at 100 kc/sec. intervals over the whole spectrum. The manner in which this circuit is added to the previously described standard is explained in the text.

This is exactly the method described under "Use of Harmonics" in Part 2 of this article. In that section a warning was issued against the use of a spurious zero beat, but in the present case the question of spurious beats can almost be disregarded, since we have three points on the waveband that were obtained using the fundamental of the signal generator. The likelihood of error in these points is quite remote, so that if the harmonic method is used to obtain further points in the manner described, any errors in the latter will show up as soon as the calibration curve is plotted, for any wrong points will not lie on the smooth curve drawn through the others.

The same method of detecting spurious beats may be used as was described earlier, viz., slightly detuning the receiver and making sure that the beat note does not change with tuning. However, the whole job is made easier if as loose coupling as possible is used between the standard, the signal generator, and the receiver. This lessens the amplitude of the spurious beats much more rapidly than it attenuates the desired ones. It should

be realised that, depending on the receiver used, spurious beats will always be present in some degree.

(3) 4500-13,500 kc/sec.

On this range there will be nine points that can be identified without using the harmonic method, and this should be enough to enable the calibration curve to be drawn. On this range, however, errors in the expected tuning range of the signal generator may cause either 4000 kc/sec. or 14,000 kc/sec. to be on the dial. If this is so, it is possible to label the points wrongly, each being 1000 kc/sec. too high or too low, so that a special check must be performed to take care of this possibility. The procedure is the same as before, the receiver calibrations being used to identify the signals, so that trouble is not likely to arise, but if the receiver calibration is suspected, all that needs to be done is to tune in WWV on 10 mc/sec., and find which of the signal-generator's calibration points on the 4500-13,500 band corresponds with this. Both the 5 mc/sec. and the 10 mc/sec. WWV transmissions may be used, giving two very positive checks, after which there will be no possibility of wrongly marking the calibration points.

(4) 9000-27,000 kc/sec.

Exactly the same procedure is used as before, the 1000 kc/sec. points being marked in the usual way. It is good policy on this band to check with WWV which is the 10 mc/sec. point, even if the receiver is not suspected. Having verified this, the remaining points are not in doubt.

(5) Low-Frequency Band.

In the illustration given above, the calibration of a possible low frequency band, such as 200-600 kc/sec., has been omitted, purposely. It would be possible to calibrate such a band by the harmonic method, using broadcast stations as the frequency standards and the second harmonic of the signal generator. This would give points between 275 and 600 kc/sec. quite satisfactorily. If, however, the low frequency range were from, say, 150 kc/sec to 500 kc/sec., this would leave a gap between 275 and 150 kc/sec. Using the third harmonic of the signal generator would enable this gap to be filled in. However, the most satisfactory way of calibrating this range is by using a secondary standard that gives signals below 1000 kc/sec.

EXTENDING THE STANDARD

The frequency standard already described gives a series of signals spaced at 1 mc/sec. intervals, each signal being a harmonic of the 1000 kc/sec. oscillator. As mentioned in the last paragraph, positive calibration of the low-frequency band of a signal generator requires standard signals lower in frequency than 1000 kc/sec., so that the frequency standard as so far constructed has a rather severe limitation in this respect. In addition, a standard that gives signals at only 1000 kc/sec. intervals does not allow odd frequencies to be measured. The cure for both these deficiencies is to add to the standard equipment which will produce at will signals spaced at 100 kc/sec. intervals, and 10 kc/sec. intervals.

THE 100 kc/sec. MULTIVIBRATOR

In order to produce signals at intervals of 100 kc/sec. a 100 kc/sec. oscillator must be employed. The type of oscillator used for this purpose is a multivibrator. This is used for two reasons. First, it gives a very highly distorted wave-form which contains a high percentage of harmonics. Thus, when the multivibrator is adjusted correctly to frequency, signals can be picked up on its harmonics up to quite high frequencies. The signals available will, therefore, be 100, 200, 300, 400, 500, etc., kc/sec. up to at least 10 mc/sec.

The second reason for using a multivibrator is that this type of oscillator is very easily synchronised by injecting into the circuit voltages at one of its harmonics. In this way, its frequency may be locked to exactly the right value by injecting some of the output of the 100 kc/sec. oscillator. In the circuit shown, V_2 and V_3 form the multivibrator, V_4 is a cathode-follower buffer stage enabling output to be taken from V_3 without upsetting the frequency of the multivibrator, while V_1 is a tube used to feed the 1000 kc/sec. synchronising voltage into the plate circuit of the multivibrator.

CONNECTION TO EXISTING CIRCUIT

In order to conserve space, the circuit of the whole standard, including the previous section, has not been redrawn. However, the extra valves may be mounted on the same chassis as the remainder of the circuit, and powered from the same supply. Input to the synchronising tube V_1 is obtained from the 1000 kc/sec. oscillator via the cathode follower buffer stage. In the circuit in Part III of the series, the cathode load was drawn as a potentiometer, from which an output is obtained through the moving arm. This connection was provided for the purpose of providing the input for V_1 on the present circuit.

The H.T. voltage for the multivibrator unit

is obtained from the anode of the VR150/30 in the original circuit. Since this imposes an extra drain through the resistor in series with the VR tube, the value of the former may have to be reduced. This is necessary only if the VR tube draws less than 5 ma. when the additional drain is imposed. Since the series resistor previously recommended was a 10,000-ohm 10-watt type with slider adjustment, this should present no difficulty.

OUTPUT ARRANGEMENTS

The cathode follower fed from V_3 provides two outputs, one from the cathode, and one from the cathode load potentiometer. Output 1 is taken to a distorter stage exactly similar to that used to follow the 1000 kc/sec. cathode follower. The tube and all circuit constants are the same as for the original 6AC7/1852, shown as V_4 in the first circuit. When it has been wired up, the plate pins of both 6AC7 are connected together to form the single output lead for the whole circuit. Not shown on the circuit here is the fact that a switch should be included in the H.T. lead to the whole of the added section. This makes it possible to use the original part of the circuit, or the whole circuit according to requirements.

ADJUSTMENT

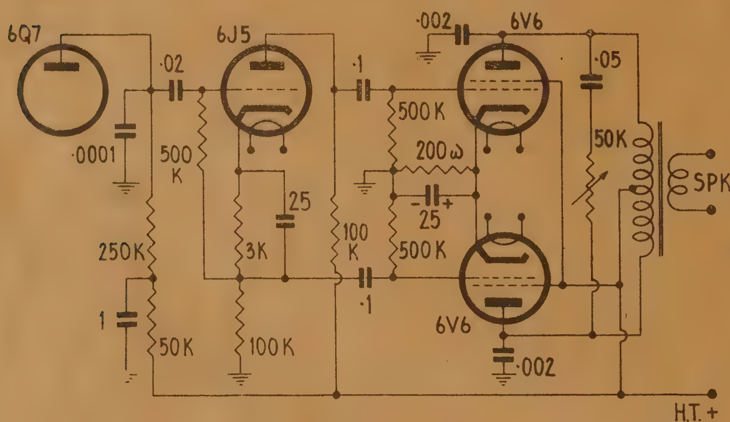
The adjustment of the multivibrator so that it works correctly at 100 kc/sec., and not at any other sub-multiple of 1000 kc/sec., is one requiring careful manipulation, and will be described in the next part of this series.

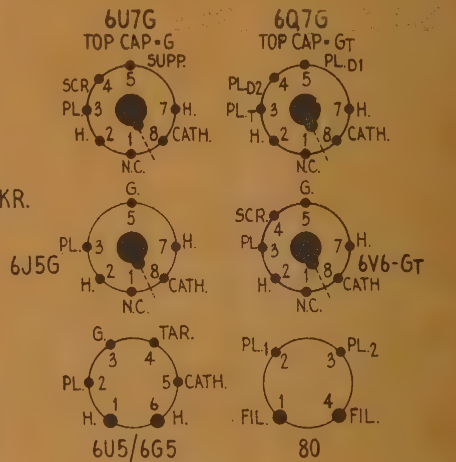
(To be continued.)

A 9-WATT PUSH-PULL 6V6 AMPLIFIER

This amplifier combines high output capability with a minimum of complication, and an economical power supply demand. It is admirably suited to the purpose of boosting power output of existing receivers such as the Radel Broadcast or Dual Wave Five, or the Bandspread Six.

It is very often convenient to have available greater power output than is provided by the average radio receiver. An amplifier of the sort described here is very easy to construct, as its three valves (excluding the 1st audio stage in the existing receiver) are connected in a circuit which has none of the complications which, while often desirable, make the amplifier somewhat critical in respect of the output transformer or the exact matching of valves. In order to further simplify the circuit, no negative feed-back has been incorporated, but the well-tried shunt condenser resistor circuit has been retained for purposes of control of high frequency response.





THE CIRCUIT

The circuit shows the 6J5 phase-inverter followed by the push-pull 6V6 output stage. Also included is the plate circuit of the 1st audio stage, which has been shown as a 6Q7. This is because all three of the sets mentioned earlier employ this valve, but if it is desired to attach the amplifier to any other receiver, it is quite immaterial what tube is used in this position. The input to the amplifier proper is the plate side of the $0.02\mu f.$ condenser which couples to the 6J5 grid.

In some cases it may be desired to feed the amplifier straight from the 2nd detector of the receiver. If this is so, the 6Q7, or other 1st audio stage, will need to be mounted on the amplifier chassis. It is for this reason that the plate coupling network of the 1st stage has been shown on the diagram. The $1\mu f$ condenser and the 50k. decoupling resistor are necessary only if the 1st audio stage derives its H.T. voltages from the amplifier power supply. If this stage is in the receiver, it will obtain its high voltage from the receiver power supply, so that this filter may be omitted altogether.

It will be noted that no volume control is shown on the circuit. This is because the volume control will normally be in the grid circuit of the 1st audio stage, and therefore in the receiver, so that a control in the amplifier itself is not necessary. The 6J5 circuit is quite conventional and requires no special comment.

The 6V6 output tubes each have a condenser of $0.002\mu f$ connected directly from plate to earth. A point worth mentioning is that these condensers have to withstand the D.C. plate voltage, plus the peak audio signal voltage at the plates of the valves. Their rating should, therefore, be at least 600 volts in order to allow a sufficient margin of safety.

THE TONE CONTROL

For some purposes it may not be desirable to have a variable control of the high frequency response of the amplifier. In this case, a good plan would be to substitute a fixed resistor for the 50k. potentiometer, which is in series with the $0.05\mu f$ condenser across the output transformer primary. The value should be found by trial to give the high frequency response desired. The smaller the value of this resistor, the smaller will be the high frequency response.

POWER SUPPLY

A power supply suitable for the amplifier needs only an 80 ma. transformer as this does not have to supply any of the valves in the receiver itself. Only one smoothing choke will be necessary, and this can be the loud-speaker field of 1500 or 2000 ohms. The former value will give somewhat higher output owing to the higher H.T. voltage delivered to the tubes. The rectifier can be an 80.

BOURNE INSTRUMENTS
COSSOR
Rola
POTTER & BRUMFIELD
CINEMA ENGINEERING
COSMOCORD LIMITED
LICENSED BY BRUSH CRYSTAL CO. LTD.
Constant Voltage Transformers SOLA
UTC
G-C
GENERAL CEMENT MFG. COMPANY
BIRKO
DIALCO
SSS
STEANE'S SOUND SYSTEMS
ADVANCE COMPONENTS LTD
Delta
BIRD
hp
HEWLETT-PACKARD
Simpson
AERIALITE
Eimac TUBES
JB
Carr Fastener
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BERCO
NEOSID
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72-inch EXTENDED

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Auto Radio AERIALS

28″ CLOSED; 72″ EXTENDED

3 SECTIONS. HEAVY DUTY

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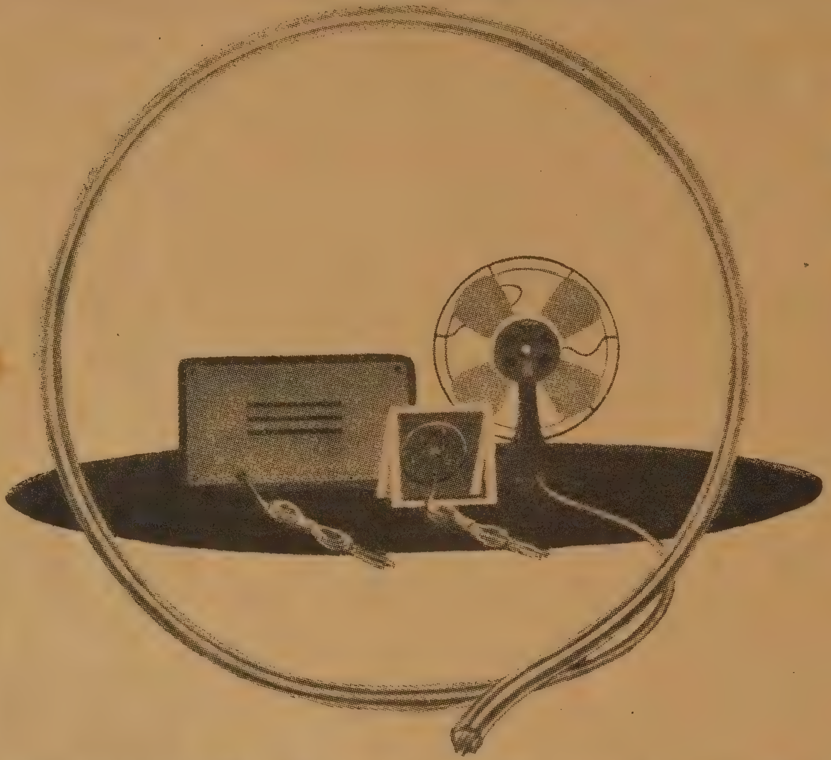


OUR GOSSIP COLUMN

We believe George Wooller, of G. A. Wooller Ltd., has been taking a well-earned rest in Rotorua. As Rotorua is renowned for its golf course, and George for his golf enthusiasm, we need say no more, except rumour hath it that George was off his game.

Now, George, this opens up an interesting problem. There are many things which will put a man off his game—good sales, bad sales, barking dogs, small boys, good news, bad news, and, alas, no news at all.

We quote Stephen Leacock who has put considerable research into disturbances likely to effect the ancient game. "All this may be explained mathematically by the simple application of the theory of permutations and probability: let us say that altogether there are 50 forms of disturbance which could put you off your game. Each one of these disturbances happens, say, once in ten days. What chance is there that a day will come when **not a single one of them will occur?** The formula is a little complicated, but mathematicians will recognise the answer at once as $\frac{x}{1} + \frac{x^2}{1x} \ldots \frac{x^n}{1}$.
That, in fact, is exactly how often you play at your best:— $\frac{x}{1} \times \frac{x^2}{1} \ldots \frac{x^n}{1}$.
Worked out in time and reckoning four games to the week, and allowing for leap years and solar eclipses, it comes to about once in 2,930,000 years."

So why worry, George—your chance of having a care-free game is pretty slim.

* * *

Charles Hart, Sales Manager of National Carbon, is now in Australia attending a sales conference. As Charles has his home in Melbourne, he is taking the opportunity to combine leave with his Australian visit. We expect Charles to return to New Zealand towards the end of the year.

* * *

The name of W. G. Leatham is now becoming familiar in the radio world, but Guy has been active in radio, both professionally and as an amateur, since 1919.

He took a degree in Electrical Engineering in 1928, and the following year joined the Western Electric Co., where he occupied the position of Operating Manager, Director and Chief Engineer until he resigned. His next appointment was to Collier and Beale's Special Apparatus Department which preceded his joining the Air Force, with which he saw service in the Solomons as a commissioned Radar Officer.

On release from the Service, he commenced business as an importer and manufacturers' representative of radio and electrical equipment.

* * *

Mr. Cliff Lewis, Manager of Radio (1936) Ltd., and Mr. Urlwin, of H. C. Urlwin, Christchurch, have been in Wellington attending a meeting of the Manufacturers' Association.

* * *

Mr. A. Wyness, Managing Director of His Masters Voice (N.Z.) Ltd., has returned to New Zealand after a visit to the parent company in England. Mr. Wyness travelled to and from England by air.

A Southern visitor to Wellington recently was Mr. E. F. Reid, who has just taken over Eclipse Radio, Dunedin. We wish him all the best in his new business.

* * *

Lindsay Bowers, of Bowers Radio, New Plymouth, has been on a short business trip to the Queen City.

* * *

Jock Wilson has recently left Cory-Wright and Salmon Ltd., Wellington, to join the Hohner Electrical Company, and will act as Sales Representative for that organisation. Jock is just on his first tour for Hohner, and dealers throughout New Zealand may look forward to meeting him in the very near future.

* * *

NEW ZEALAND ELECTRONICS INSTITUTE

The formation and activities of the various branches of the N.Z. Electronics Institute are well under way, and it has been most satisfying to see the large and representative attendances at the branch meetings.

Although the Institute is as yet only in its embryo stage, it should be remembered that this is the first time that an effort has been made to unify all those who control or handle electronics in all its phases. Up to the present, each branch of electronics has continued its progress and development largely unmindful of the problems and difficulties of allied branches. It can now be seen that, in addition to the many other important functions of the Institute, another vital link in the chain of electronics can be welded by a genuine effort to co-ordinate the endeavours of all associated with the use of an electron from the physicist in the laboratory, down to the student in our schools.

The all-important fact is that the Institute has been formed, but to enable it to function in accordance with its aims and objects, it must have as its members everyone in New Zealand who is associated with electronics. The promoters of the Institute have taken the initiative, and have given to the country a unified body, the value of which will be impossible to forecast. They have done their part, and it is now "over to you."

Until such time as all branches are completely formed, application papers, together with data on membership requirements may be obtained from the Secretary, N.Z. Electronics Institute, G.P.O. Box 219, Wellington, who in turn will advise the appropriate branch.

BRANCH NEWS

The Dunedin and Christchurch Branches have been doing really excellent work, both in providing interesting lectures and in securing good attendances.

The Dunedin Branch was formed on 5th September, the executive appointed being: President, Mr. W. L. Shiel; Vice-President, Mr. W. G. Collett; Management Committee, Messrs. J. G. Coombs, M.Sc., A. R. Harris, J. P. Pickerill, R. E. Richardson, N. H. Shepherd (Treas.), T. Stone; Secretary, J. Hall.

The Christchurch Branch was formed last July, the executive comprising: Chairman, Mr. T. R. Pollard; Committee, S/Ldr. J. W. Todd, M.B.E., Messrs. G. T. Edwards, L. P. Gerity, E. Pratt; Secretary, Mr. B. G. Willis; Treasurer, Mr. J. A. Lee.

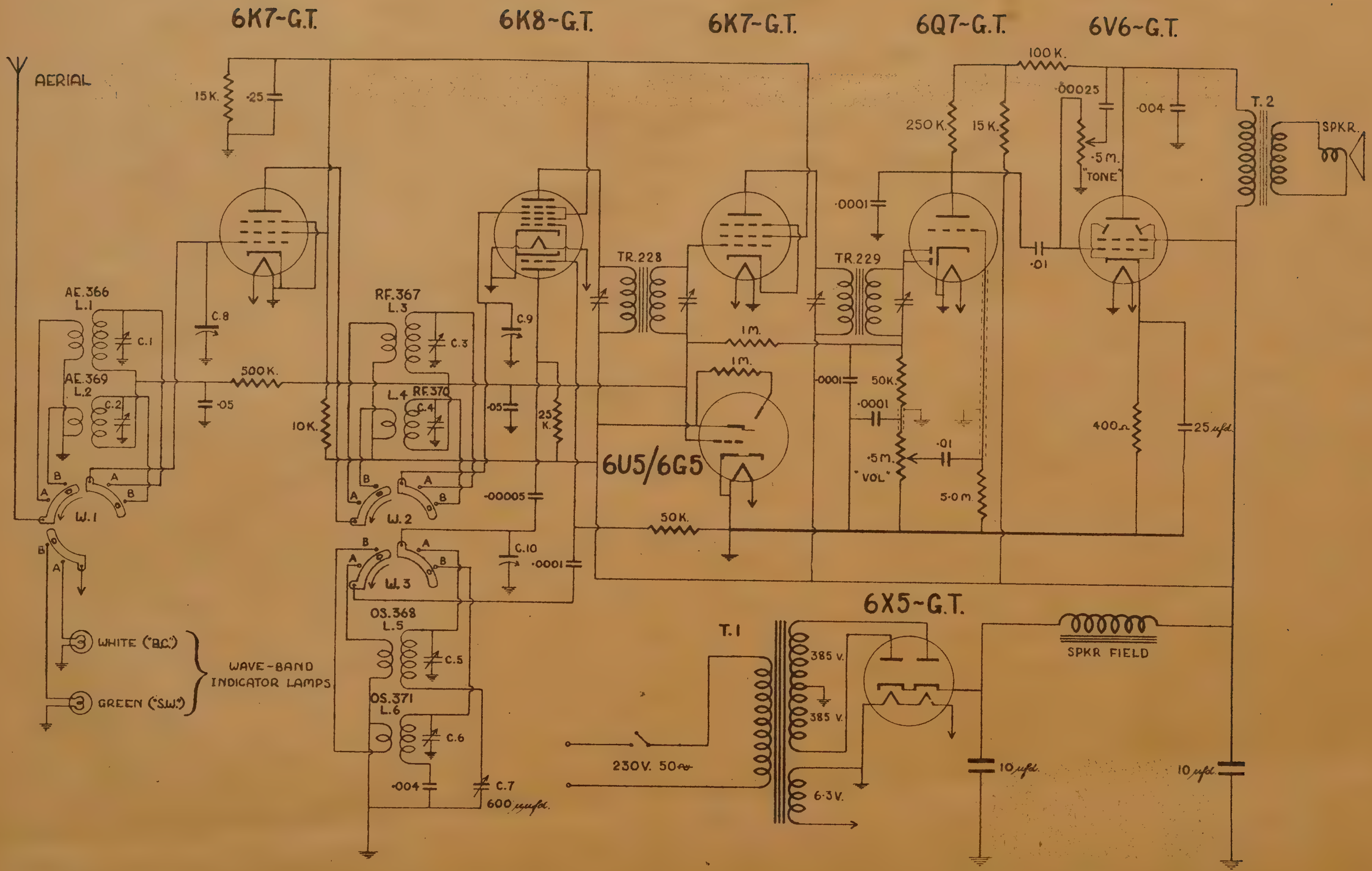


Figure 1 – Circuit Diagram

FOR THE SERVICEMAN

H.M.V. MODEL 467D

Intermediate Frequency:
455 kc/sec.

Frequency Ranges:
Broadcast: 540–1750 kc/sec.
Short-wave: 5.5–19 mc/sec.

Alignment Frequencies:
Broadcast: 600 kc/sec. and 1400 kc/sec.
Short-wave: 6 mc/sec. and 18 mc/sec.

I.F. Alignment:

Test oscillator should be connected to the 6K8 grid through a 0.05μf. condenser, and the wave-change switch should be in the Broadcast position, with tuning dial rotated to the position at the low frequency end, giving minimum interference. Adjustments should be made with the smallest practicable signal so as to avoid operating the A.V.C.

Over-all Alignment:

Alignment of the R.F. 1st detector and oscillator trimmers and the oscillator padder should be carried out on the frequencies specified, normal procedure being used. This part of the alignment calls for no special instructions.

A Practical Beginners' Course

PART 5

In last month's instalment of this Course, we described the construction of a tapped aerial coil, so that we could make further inquiries into the subjects of selectivity and de-tuning.

We will suppose now that the tapped aerial coil has been constructed, and that some kind of outside aerial has been erected. What then are the advantages of the tapped aerial coil over the un-tapped one originally constructed?

When the aerial is connected to the end of the aerial coil, so as to include all its turns in the circuit, the set is now exactly the same as the one with the untapped aerial coil. Like this one, the selectivity will be better than that of the original set which had no aerial coil at all, and, in addition, there will be less de-tuning effect. In other words, the stations should come in best at points on the tuning condenser roughly corresponding to where they are received on the dial of a manufactured set. The low frequency stations should be received near the closed position of the condensers, and the stations on higher frequencies will be heard with the condenser plates more opened. Of course, this is the case whatever the range of frequencies actually covered by the set. There may be many people who never listen directly to 2YA on their big sets, but every set sold must have this station on the dial, since the set may have to be used anywhere in the country. In just the same way, we have to give specifications of our crystal sets in such a way that, wherever they are built, the local broadcasting stations are able to be received. Consequently, de-tuning of the set by the aerial must be avoided in a crystal set just as much as in any set made for sale by a manufacturer.

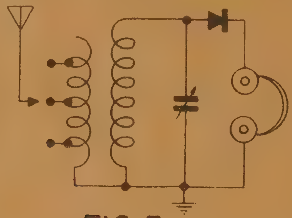


FIG. 5

The circuit with which the accompanying experiments are performed.

AN EXPERIMENT

As was mentioned before, using an aerial coil allows the aerial to be connected with very much less de-tuning than occurs when the aerial is taken straight to the top of the tuned circuit. You can easily demonstrate this to yourself by temporarily connecting the aerial to the top of the tuned circuit as though the aerial coil were not there. Then, rotate the tuning condenser until your main local station (the one most easily received) is heard at its loudest. Now, note the position of the rotor (moving vanes) of the tuning condenser. Next, disconnect the aerial and attach it instead to the un-earthed end of the aerial coil. This places the whole of the coil in use. Now, re-tune the receiver with the tuning condenser, and again note its position. There will have been a considerable shift necessary in the tuning condenser position, and the amount of this shift gives a measure of the amount of de-tuning caused by the aerial in the original set.

Now connect the aerial to each of the tappings in turn, and at each tapping, re-tune the set and note how much the condenser has had to be shifted from the previous position. From doing all this you will find—

(1) That as a smaller and smaller section of the tapped aerial coil is used, so does the amount of shift necessary for the condenser become less and less. In fact, for the last few tappings it may not be possible to notice any shift at all. This shows that as long as not too large an aerial coil is used, making it still smaller has very little effect on the tuning of the set.

(2) As the aerial is tapped down the coil, so the set becomes more selective. That is to say, it is easier to tune one station **in** and another **out** with the **same** movement of the condenser. If you have two stations which can both be heard at the same time on our original circuit, it will be quite easy to notice this improvement in selectivity. When the aerial coil is put into use, it may still be possible to hear the second station when the condenser is tuned for best reception of the first, but you should be able to notice that the unwanted station is now much weaker by comparison than it was when no aerial coil was used. In this case, the set is doing a better job of **selecting** the station to which it is tuned, and at the same time rejecting the other station.

If you have only one station audible, you can judge the selectivity of the set in another way. First of all, go back to the old connection with the aerial at the top of the tuned circuit, and listen for the station. When you hear it, turn the tuning condenser slowly to either side of the point where it comes in best. You will find that quite large movements of the tuning condenser can be made before the loudness in the headphones drops appreciably. In other words, the tuning is very "broad," and it is hard to find the **exact** spot on the dial where it comes in at greatest volume.

Now, transfer the aerial to the top end of the aerial coil, and tune in the station again. Rotate the tuning condenser as before, and you will notice that now a comparatively small movement will be enough to cause the station to become quite weak, or even to be lost altogether. Continue the procedure by tapping the aerial connection further down the coil and rotating the condenser again. Although using a smaller aerial coil will not have as much effect on the selectivity as the original change from no aerial coil to aerial coil, it should be possible, with careful tuning and listening, to notice that as the coil is made smaller, by tapping further down, so the sharpness of tuning increases. When only five turns of the aerial coil are in use, only a small rotation of the condenser will be sufficient to tune right through the station.

(3) While you are performing these experiments, you will probably have noticed that, as well as affecting selectivity and aerial de-tuning, the use of the various tappings on the aerial coil also affects the volume of the signal in the headphones. If you have not already noticed this, it can be made the subject of a separate experiment. This time, you will have to be careful to find a good spot on the crystal, and not to disturb the cat's-whisker throughout the experiment, otherwise a proper comparison will not be obtained. The tests can be made, as before, first without the aerial coil, and then with successively lower taps on the latter, re-tuning each time for greatest volume. So that you can see what is happening, make a note each time you change the aerial connection and have retuned, writing simply "louder" or "softer," to indicate whether the signal is louder or softer than at the previous step. This is quite difficult to do, as it is not easy to remember just how loud the last step was unless there is a very marked difference. However, if you are not sure as to some of the results, do the experiment all over again, without looking at your first list of results, and then compare the two sets of answers.

With this volume experiment, it is not possible to say just what the result will be in any particular case, even though the set is built exactly as we have described. This is because the effects that can come into play are really quite complex, and depend as much on the exact properties of the aerial used as on the set itself. However, it is possible to indicate some of the likely effects.

As before, the greatest change can be expected when the alteration is made from direct connection to the tuned circuit to using the aerial coil. It is possible here that either an increase or a decrease in volume may be noticed, but an increase is quite likely. This is because of an effect called **damping**, which has not so far been mentioned, and which we will explain later on. Briefly, the effect of this damping is to decrease the amount of amplification provided by the tuned circuit. When the aerial is removed from the tuned circuit and applied instead to the aerial coil, the damping, or loss of amplification, is reduced, the tuned circuit amplifies the minute aerial currents more effectively, and so a louder signal is heard in the headphones. Now, as the aerial is connected to lower tappings on the aerial coil, the damping decreases still further, and it may be possible to hear the increase in volume that results.

But there is another effect which can cause a reduction in volume when the aerial coil is put into

use. It is a matter of the coupling between the aerial coil and the tuned circuit. When the aerial coil is not in use, all the aerial currents flow through the tuned circuit's coil, but when the tapped coil is used, a reduction in volume may come about because the coupling between the aerial coil and the tuning coil is not 100 per cent. efficient. Which of these two effects predominates—the increase of amplification or the lack of complete coupling—will determine in any one case whether, using the aerial coil, causes an increase or a decrease in volume. The most likely thing is that, with a long, high aerial, there will be a noticeable increase of volume, but with a poor short aerial (such as an indoor one) there will be a decrease.

You might now be wondering if the aerial coil is not coupled with the tuning coil in the most efficient possible manner, why we do not take steps to remedy this defect. The answer is that if we made the aerial coil coupling too tight, we would be right back where we started, with bad de-tuning and poor selectivity. A comparatively inefficient aerial coupling is the price that must be paid for the benefits of improved selectivity and less de-tuning, and there is very little that can be done about it.

We have enlarged upon the operation of the crystal set with the tapped aerial coil because, by so doing, there is much to be learned. If we remember all we have found out so far about the manner in which the crystal circuits perform, we will have advanced quite a long way towards understanding bigger sets. This is because the themes we have been discussing—selectivity, coil couplings, etc.—find application in just the same way in any radio set of which we like to think. In addition, our further discussion of crystal set circuits will also find application later on. For the beginner, though, the crystal set is the ideal one with which to perform these experiments, partly because of cheapness, and partly because even the simplest valve circuits introduce new problems for which we are not yet ready, and which would hide the fundamental or basic lessons we are trying to learn at this stage.

This is just a bit of encouragement to those who may think that we are not progressing fast enough, and who want to dive, as it were, into the construction of valve sets because these are able to give better reception than crystal sets. Our advice, therefore, is to follow our series through as closely as you can, for each experiment will make you readier, when the time comes, to build more advanced sets, without the discouragement of not being able to make them work properly at the first try.

Returning now to methods of increasing selectivity and reducing damping and de-tuning by the aerial, it will have been noticed that we have not yet referred to the circuit of Fig. 4. Here, the aerial coil has been dispensed with, but the aerial is connected instead to a tapping on the tuning coil itself. This has almost the same effect as using a separate aerial coil which has the same number of turns as the portion of the tuning coil between the tapping point and the earthed end. Thus, it need not be considered separately. Later on we will have occasion to build a set with tappings all down the tuning coil. When this has been done, the scheme can be tried out, but since its performance is almost the same as that of Fig. 5, there is no point in making it the subject of a separate experiment.

TRADE WINDS

MR. W. MARKS

It is with very great regret that we record the death of Mr. W. Marks, Managing Director of Radio Corporation of New Zealand Limited.

Mr. Marks came to New Zealand in 1926, and in his early days was employed as an electrician by the Wellington City Council. Very soon, however, his ambition and energy moved him to make a start on his own account, which he did by undertaking rewinding of transformers and repairs of electrical apparatus.

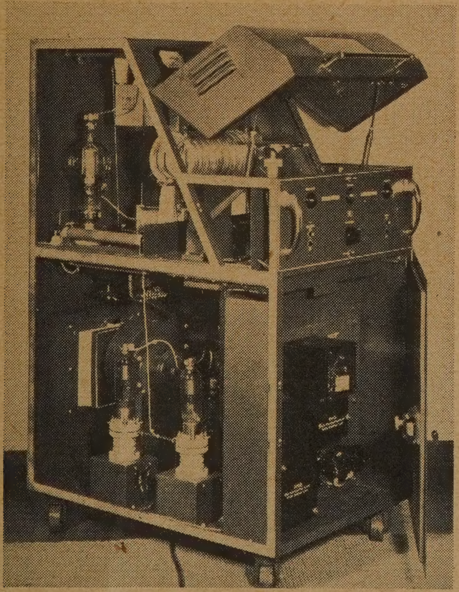
By 1931 he had founded the firm of W. Marks Ltd., manufacturing domestic radio receivers under the trade name of Courtenay. In 1932 the company was further expanded into Radio Corporation (N.Z.) Ltd. The year 1933 saw the company expanding further, and the move to the present premises in Courtenay Place.

The organisation became a public company in 1936, bearing the name of "Radio Corporation of New Zealand Limited," with Mr. Marks as Managing Director. To-day, Radio Corporation and its Columbus network of Radio Centres stands as a tribute to the personality, spirit and enterprise of one who was affectionately known as "W.M."

* * *

S.T.C. DEMONSTRATE R.F. HEATING

Messrs. Standard Telephones and Cables gave a demonstration of the "Megatherm" R.F. Heating Equipment a few days ago. While it is not possible in this column to deal at length with the advantages and modern industrial applications of this equipment, some interesting features are worthy of note.

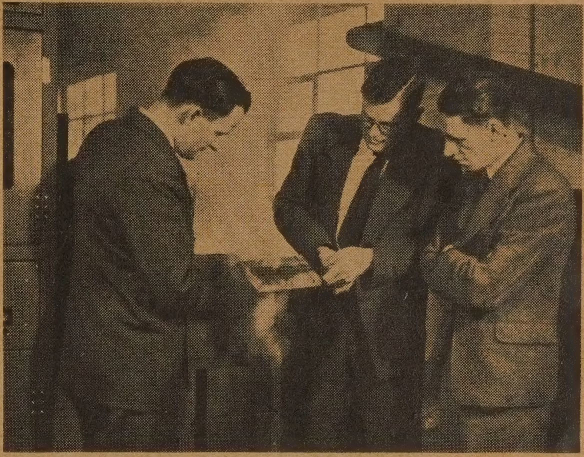


The ½ kw. Megatherm R.F. Heating Equipment.

Two types of equipment were shown—one ½ kw. and the other 3 kw. The 3 kw. set was the type demonstrated.

It was possible to raise the temperature of ½ inch timber to 212 degrees in 25 seconds. The timber was completely de-hydrated in this time, and in a total period of 45 seconds the wood was set on fire.

It was interesting to note that, as the outer surface cooled more quickly owing to air circulation and the heating by R.F. means is uniform throughout the thickness of the material, the wood sample began to burn from the **inside outward.** As the wood commenced to burn, the smoke poured out of the nail holes and flaws of the timber.



Jack Wilson, Sales Rep. of S.T.C., Phil Humpries, Engineer, S.T.C., and Doug. Foster, Technical Editor of "Radio and Electronics," inspect the burning sample of timber during the Megatherm demonstration.

When used for pre-heating of plastics, the moulding temperature (approx. 350 degrees) can be obtained in 60 seconds.

Although R.F. heating is comparatively new in New Zealand industry, we feel sure that, in the very near future, R.F. heating will lead electronics to new and important industrial applications.

* * *

We have been advised by National Electric that the General Electric Industrial Tube Manual is now available, and already a large demand has been forthcoming from the N.Z. industry.

The manual contains over 400 pages of drawings, performance curves, ratings and typical circuits. Every type of tube has its section—Ignitrons, Thyratrons, Kenotrons, Pliotrons, Photo-tubes, Glow Tubes, Ballast Tubes, Vacuum gauges and switches. The volume is well bound in loose-leaf form.

The estimated cost is expected to be not more than 21/- per copy, and a replacement sheet service will be provided for 12/6 per annum. All those requiring copies of the G.E. Manual and supplements should apply to The National Electrical and Engineering Co., Ltd., Wellington.

* * *

Mr. H. R. Halliday, who was for many years Resident Engineer of Enfield Cables Ltd., Australia, has recently joined International Radio Co. as Australian Manager and Technical Director.

Born in Western Australia, Mr. Halliday trained with Messrs. Atkins (W.A.) Ltd., in their Electrical Engineering Dept.

He graduated in Arts at the University of Western Australia and secured the Diploma in Mechanical and Electrical Engineering at the Perth Technical College.

He is an Associate Member of the Institution of Engineers, Australia, and of the Institution of Electrical Engineers of Great Britain.

Mr. Halliday went to England in 1930, and joined the super tension staff of Enfield Cables Ltd., London, and was engaged on research, manufacture, testing and installation of cables up to 132,000 volts.

In 1934 he returned to Australia as Resident Engineer for Enfield Cables, a position he held until his recent appointment.

WIDE BAND AMPLIFIERS

(Continued from page 10.)

This gain will be realised only if Rg, the following grid resistor, is much greater than Rl. If the maximum value for a 6AC7 of 0.5 meg. is used, this condition is clearly fulfilled.

It is interesting to note that had a response level to 2 mc/sec. been obtained without the use of the shunt-peaking circuit, i.e., by simply using a lower value of Rl, the available stage gain would have been only about a fifth of the value attained by the compensated circuit.

(To be continued)

NEW DIELECTRIC AND INSULATING MATERIALS IN RADIO ENGINEERING

A discussion on "New Dielectric and Insulating Materials in Radio Engineering" was opened by Dr. J. C. Swallow and Mr. G. P. Britton, at a recent meeting of the Radio Section of the British Institution of Electrical Engineers. The most important of these new materials, many of which had been introduced during the war, were based on high polymers and ceramics. Plastics based on hydrocarbons possessed the desirable properties of low permittivity and power factor, combined with low water absorption. Polystyrene, polythene, high molecular weight polyisobutylene and butyl rubber were examples having widely different mechanical properties. Early attempts to obtain intermediate mechanical properties by mixing these materials in different proportions had led to no useful technical mixture other than polythene-polyisobutylene, which had been used to a considerable extent in the insulation of high-frequency cables. This usefulness of hydrocarbon plastics might be increased by the production of new forms, such as film, and also in the case of polythene, by the production of fibres of reasonable strength which could be applied as thin layers on wire.

In the field of composite dielectrics there were the new low-pressure laminating resins which, when used with glass cloth, gave a good combination of mechanical and electrical properties for radar fairings. With the advances being made in synthetic fibres, new laminated materials with improved properties might be expected, in which the silicones might play an important part. Polyvinyl-chloride compositions had been successfully introduced for normal insulation, and had the advantages of freedom from aging, non-inflammability and bright colouring for identification purposes. Ceramics represented a group of insulating materials based on another type of chemical structure which led to different combinations of electrical properties.

Materials based on magnesium silicate (soapstone or talc) were almost universally used for insulators when moderate permittivity and low power factor were required. A technique which considerably widened the application of this class of material was that insulators made of it could be coated with firmly adherent metallic films to which metal parts might be soldered. This technique was now being generally applied for solder assembly of components, hermetic sealing of tropical equipment and, on an experimental basis, vacuum tube work. In the field of condenser-dielectric ceramics with permittivities ranging from 10 to 100, considerable progress was being made experimentally in the improvement of electrical properties. These materials, based mainly on titanium dioxide, had given trouble in respect of power factor variation with frequency. Close study of the behaviour of the titanium dioxide, notably of its tendency to reduction to what was believed to be a suboxide with semi-conducting properties, had shown how lower power factors might be achieved. The result was likely to be a considerable improvement in quality. Another useful step had been the development of a range of dielectrics of closely controlled temperature coefficient of permittivity.

A new group of materials with an extremely high permittivity was based mainly on titanates of metals of the alkaline earth group. Complex titanates of barium, strontium and calcium could be made with very high average permittivities. Many of the compositions investigated showed considerable variation of power factor with frequency and temperature, and their temperature/permittivity curves gave remarkable permittivity peaks. By introducing certain materials, other than titanates, it was possible to modify, reduce or eliminate these peaks and produce materials of average permittivity with only moderate variation of permittivity with temperature. While most of the complex titanate ceramics exhibited mediocre power factors of 1 per cent. and upwards, certain additives effected marked improvements, usually at the expense of reduced permittivity. Enough research had been carried out to indicate the possibilities of ceramics of this class; and there would seem to be scope for development for a long time.

In the course of the discussion, it was pointed out that many of the new materials were difficult to use in the small workshop, although they were cheap and easy to work on a mass-production scale. Polythylene could be machined without much difficulty, but ebonite retained its popularity for experimental purposes. It was possible, however, that the use of a simple press would enable plastic mouldings to be made as quickly and cheaply as fabricated parts, even when only a small number was required. The progress of ceramic development had provided much information on a range of new materials with properties which still required fundamental examination. The titanates had been described as "ferro-electrics," a term which was intended to stress the analogy between these materials and the behaviour of ferromagnetic bodies in a magnetic field. Examples of this behaviour were the change of permittivity with applied voltage and the sharp rise of permittivity at a critical temperature. In mixtures of the ceramic materials these effects were considerably modified.

The danger of releasing new materials for commercial use before they were adequately understood was stressed; and it was pointed out that the use of the abnormal properties of the components made from these materials could not be safely exploited until a stable production had been achieved.

PUBLICATIONS RECEIVED

Philips Technical Review.

We welcome an old acquaintance from the world of pre-war technical literature: the Philips Technical Review. The January, 1946, number, with which the Review begins its eighth volume, opens with an introduction by the editors on the occasion of its reappearance after some years of forced interruption.

On the radio side the main interest in the January number will be an article by J. M. van Hofweegen on the measurement of impedances at radio frequencies. This article includes a description of a new measuring technique for decimeter wavelengths, developed in the P' ilips laboratories. The method uses lecher wires.

There are also articles on a Philips-designed stroboscope for visual and photographic purposes, an X-ray apparatus of new design suitable for contact rather than

depth therapy, and a leading article on "Sintered Glass" by E. G. Dorgelo.

The February, 1946, issue of the Review contains two articles of particular interest to radio and sound engineers: first, an article by Th. J. Weijers on "Frequency Modulation," which includes an excellent resume of the known types of modulation, and shows how the old idea that frequency modulation would increase the number of possible channels in a given band of frequencies is quite erroneous.

In an article entitled "The Formation of Stereophonic Images" K. de Boer discusses the problem of causing sound to emanate apparently from that part of a picture screen where the observer knows the sound would in real life originate. The article discusses at length the manner in which sound must be recorded in order to produce this effect. The writer shows how stereophonic reproduction, even when the source of the sound is not "seen," gives a considerable improvement in quality.

The editors of the Review announce the publication of a new periodical "Philips Research Reports," a compilation of scientific treatises issued by the Philips laboratories. Nos. 1 and 2 of this periodical include papers on the current to a positive grid in electron tubes, the theory of the stability of lyophobic colloids, the ratio between the horizontal and vertical electric fields from a vertical antenna of infinitesimal length situated above a plane earth, the thermal expansion and Poisson contraction of cubic metals, Langmuir's space-charge theory under certain conditions of electron distribution, and a number of others.

For information regarding the supply of the Technical Review or the Research Reports, readers should apply direct to Philips Electrical Industries of New Zealand Ltd., P.O. Box 1673, Wellington.

THE ZC1

(Continued from page 19.)

crystal control, the buffer stage acting as a crystal oscillator. Throwing the switch cuts out the crystal and enables the E.C.O. to be used as originally intended.

Fig. 5 shows another method that has been successfully tried for converting to crystal control. Here, the crystal is placed in the oscillator grid circuit, and the one-time E.C.O. coil is transferred to the plate circuit of the oscillator. When this modification was made, the crystal used was working at half the output frequency, so that the oscillator was doubling in the plate circuit, but there seems no good reason why the transmitter should not work straight through at crystal frequency without any tendency to oscillate.

It is, of course, quite impossible in an article of this length to make mention of all the design features of the equipment, but the main features have been dealt with here. The ZC1 is an excellent piece of equipment for the purposes for which it was designed, and gave sterling service with our Army in the field. Those who have a requirement for a transportable, completely-equipped low-powered station could do a lot worse than put one of them into operation. However, those who do not hold amateur transmitting licences, but who may wish to use the ZC1 should first read the article in this issue entitled "Can I Use the ZC1?" before putting it on the air.

RADAR

(Continued from page 5.)

and necessitate different height-conversion charts for different directions from the station. All these things make it quite impossible to rely solely on calculated radiation patterns, so that once the equipment has been set up, a comprehensive system of test flights must be run in order to calibrate the height-finding system. Yet, in spite of all these difficulties, the scheme we have outlined was put into successful use all over the world on operational G.C.I. stations, and enabled the latter to cause to be shot down a very large number of enemy aircraft. Without height-finding, it is doubtful whether very many aircraft could have been destroyed by G.C.I. in spite of their accurate plotting in range and bearing.

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